AUTOMATION

APRIL 1956

ENGINEERING LIBRARY

FROM SHEET TO PRODUCT IN

Making Automobile Frames

The Magazine of Automatic Operations

- Relay Control
- Automatic Transmitters
- Operations Research
- Variable-Speed Control

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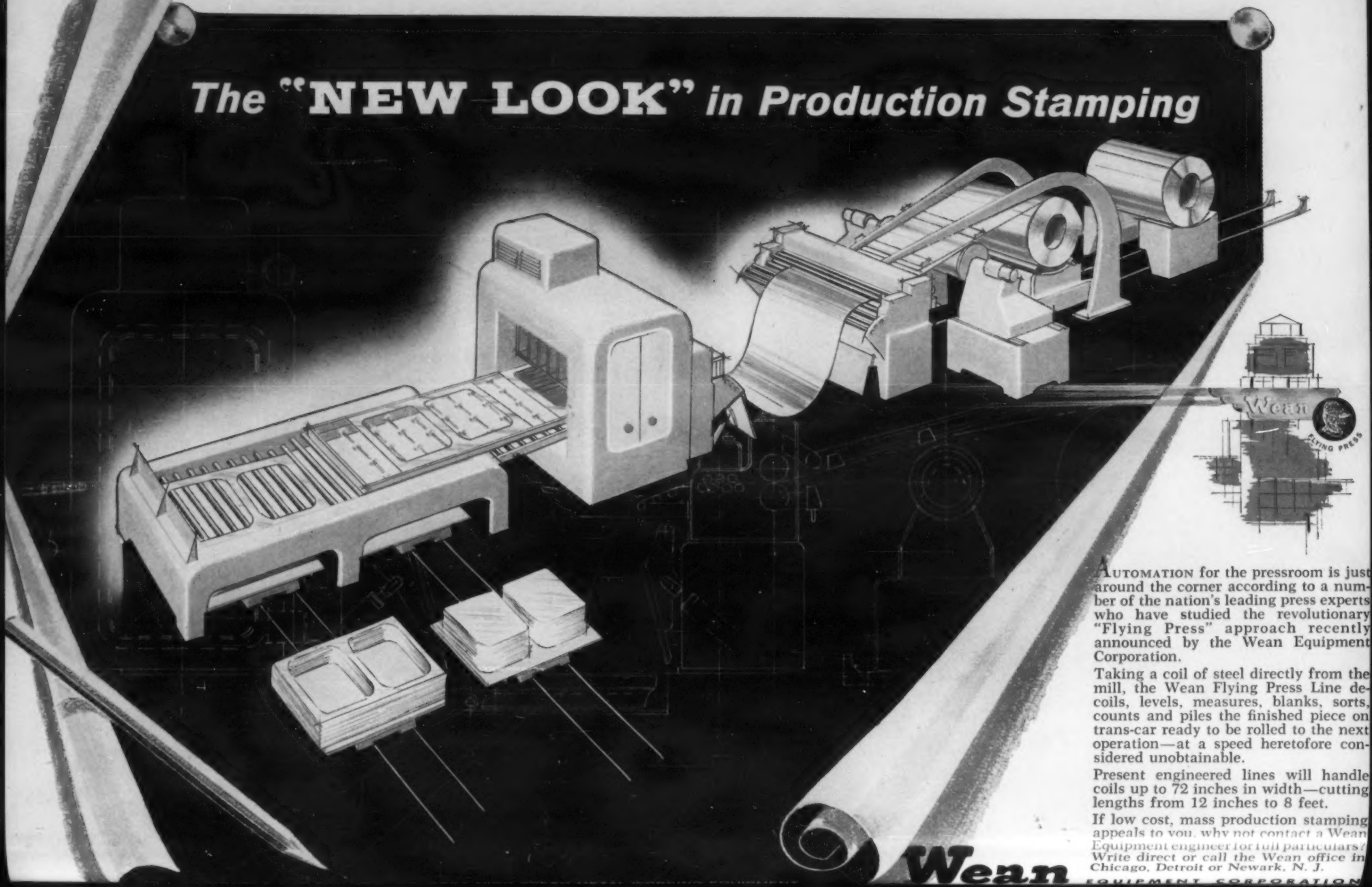
A PENTON PUBLICATION

The "NEW LOOK" in Production Stamping



AUTOMATION for the pressroom is just around the corner according to a number of the nation's leading press experts who have studied the revolutionary "Flying Press" approach recently announced by the Wean Equipment Corporation.

Taking a coil of steel directly from the mill, the Wean Flying Press Line decoils, levels, measures, blanks, sorts, counts and piles the finished piece on trans-car ready to be rolled to the next operation—at a speed heretofore considered unobtainable.

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If low cost, mass production stamping appeals to you, why not contact a Wean Equipment engineer for full particulars? Write direct or call the Wean office in Chicago, Detroit or Newark, N. J.

Wean EQUIPMENT CORPORATION

APRIL, 1956
Vol. 3—No. 4

AUTOMATION ®

THE MAGAZINE OF AUTOMATIC OPERATIONS

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automation outlook

THIS IS SO

". . . when the recent round of wage increases was handed out to labor with the guaranteed annual wage, there was much talk of further and more rapid automation coming into industry. That this is so, is reflected in the machines that National Acme is building. The wage increases spurred the manufacturers in all fields to ask for machines of all kinds with greater scope . . ."—*F. H. Chapin, president and chairman of the board, The National Acme Co.*

PROGRESS DEPENDS UPON AUTOMATION

". . . policy of diversifying by industries and related products, which was initiated in recent years, has proved so successful that our products are now used in every field of industrial and commercial endeavor. There is general recognition today that an electric motor, properly applied and controlled, is the greatest help to the advancement of our American economy and must be used in all our efforts. Future industrial progress largely depends upon automation. Despite the cries of alarm heard in some quarters, history has shown us that industrial progress has always resulted in more—not fewer—jobs and has always brought more—not less—wealth, goods and services to the ultimate benefit of all the people as a whole . . ."—*J. W. Corey, president, Reliance Electric & Engineering Co.*

FACILITY FOR MANAGEMENT CONTROL

". . . an electronic computer for handling management control functions would provide a facility for storing records of sales forecasts, sales orders, production capabilities, and inventories, and converting this information to production and shipping orders. The computing machine would be able to apply the best available industrial engineering techniques such as well known production lot size formulas and newly developing production and inventory planning procedures to determine the best production plans . . ." —*John S. Coleman, president, Burroughs Corp.*

TIMELY INDEED

". . . automation is coming along at a time when the total population of this country is increasing much faster than the number of people available for productive work. It has been estimated, for instance, that in the next ten years the population will increase by 20 per cent and the portion of the population available for work by only 6 per cent. In this situation, with proportionately fewer hands to do a lot more work, automation is going to be a very timely blessing indeed. . ." — *L. L. Colbert, president, Chrysler Corp.*

NEW CONCEPT IN INDUSTRY

". . . automation is one of the big reasons the American standard of living will rise faster in the next ten years than ever before. Not only factory processes, but many office procedures too will be automatic. Automation will cut costs, increase output per worker, and generate a chain of events leading to more and better jobs, as mechanization always has. The new concept in industry is to look upon an entire factory as a machine with co-ordinated parts. Materials flow through it continuously, carried from one operation to another on conveyors. Continuous flow, instead of stop and go, is the big idea. Keep things moving instead of picking them up and putting them down. . ." — *R. C. Sollenberger, executive vice president, Conveyor Equipment Manufacturers' Association.*

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BPA

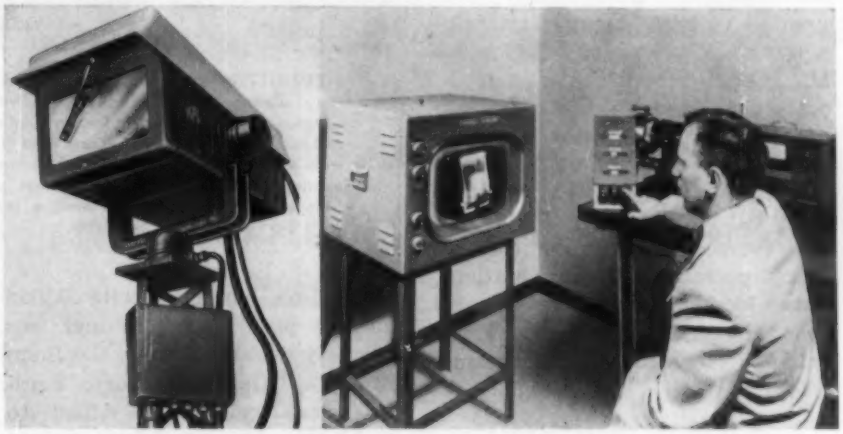
AUTOMATION news

Today's events and developments in the field of automation

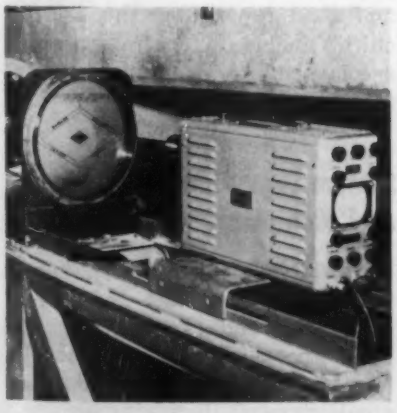
Industrial TV Improves Inspection Systems

INDUSTRIAL applications of television continue to expand as the special attributes of the medium are realized. A unique application by the General Electric Co. combines TV with X-ray equipment to form an inspection system which amounts to fluoroscoping under daylight conditions. The system produces an image direct, by electronics, from the X-ray source, thereby eliminating the complexities resulting from the need to convert the X-ray image into a light image for intensifying it.

In operation, the X-ray beam passes through the object being examined and strikes a photoconductive layer of lead-oxide located on the inside of a special pickup tube. The latent image is scanned by a low-speed electron beam which is electronically amplified and pictured on a TV viewing tube similar to the type used in conventional receivers. The signal created by the scanning beam can also be recorded on magnetic tape for a permanent record, or the TV image be photographed.



WEATHERPROOF industrial TV camera, left, is product of General Precision Laboratory Inc. The remotely operated camera is capable of scanning through 360 degrees and tilting 90 degrees. Combined X-ray and TV inspection system, right, has been developed by the General Electric Co. The TV installation is used to intensify an X-ray image directly by electronic means without the need of converting the X-ray image into a light image before intensification.



DAMAGE to a large forging press is prevented by combination of a special gage and closed circuit television system. Eccentric loading of the press is reflected by a beam of light focused in the center of a diamond-shaped gage viewed by the TV camera.

Design advances which enhance the more typical use of industrial TV include remote controlled cameras manufactured by General Precision Laboratory Inc. The units for outdoor services are equipped with a weatherproof housing. This type of equipment is used for remote monitoring of industrial operations and surveillance and security work.

Remote monitoring is a necessity in some hazardous operations, or it may be a matter of convenience as typified by an Allen B. DuMont Inc. installation for viewing loading conditions on a giant Alcoa extrusion press. In this application, off-center loads are reflected in a special hydraulic system located in the press base, and position a spot of light within a diamond-shaped outline on a special gage. Viewing the position of the spot of light in relation to the boundary of the diamond gage through a TV setup enables the operator to control the press.

Dage Television Div., Thompson Products Inc. has installed a system in a railroad interchange terminal which reflects a straightforward application of closed-circuit TV with typical savings of operating expenses. Problem involves checking the numbers on each freight car of each train arriving in the receiving yard, prior to classification. With the Dage installation, trains pass in front of TV cameras at a sufficiently slow speed to allow a clerk in the hump office to identify car type, number, etc. which he verbally reports into a tape recorder for record purposes.

The same type of convenience

is reflected in a Radio Corp. of America paper plant installation where pulp operations extend over several floors. One operator can easily monitor those operations which require a periodic visual check on the proper flow of product.

Microwave installations have been developed to overcome the expense of coaxial cable where distances of transmission are great. An early example involves a system developed by Raytheon Mfg. Co. to remotely and continuously scan forest areas in search of fires. Atop strategically located towers throughout the forest areas, the cameras rotate continuously but may be stopped, started, or reversed by remote control from central monitoring station. Exact location of fires are established by triangulation based on readings obtained from two cameras.

Computer Fire Control

NAVY Department has recently released information about a new inshore fire support ship which is designed to place rocket fire on ground troop concentrations. A key feature of the new ship is a unique two-computer combination, first to be designed especially for rocket launchers, built by Ford Instrument Co., Div. of Sperry Rand Corp. Each computer acts as a unit to perform the required navigational and ballistic calculations involved in rocket launching operations. With the computers, the ship is able to instantly switch among several types of rockets, selecting either high or low angle fire as required. The computers automatically correct for the effects of roll and pitch of the ship during the firing operation.

APPOINTMENT of **Glenn A. Richardson** as vice-president and general manager of the Allied Steel & Conveyors Div. has been announced by **John J. Smith,** president of Sparks-Withington Inc.

FLEXIBILITY is introduced to automated press production line by Clearing Machine Corp. design incorporating four individual machines in place of a single la ge transfer feed press. Built for an English concern, a lead 275-ton press and three 600-ton machines are to be arranged initially in a 19-station line to produce automobile wheels. Transfer of work between presses is automatic. Rearrangement of existing presses or addition of other presses is feasible and provides for design changes so prevalent in automobile industry.

Richardson has been with Allied for the past ten years and was formerly associated with the Bohn Brass & Aluminum Corp. Present plans called for Allied to double the size of its plant area with an expansion expected to be completed in early 1956. The expanded facilities will house new production equipment to meet a steady increase in the company's automation and conveyor business.

Dryer Regenerates Automatically

FULLY automatic air dryer, capable of delivering air with less than 1 per cent relative humidity, has been developed by the Beckman Div., Beckman Instruments Inc. It can be used with infrared spectrophotometers, in low temperature studies to prevent moisture fogging glassware, windows or mirrors, in balance enclosures or wherever reactions must be carried on under moisture free conditions.

The air dryer employs activated alumina as a drying agent. The dryer will deliver 100 cu ft of dry air per hour over a 24-hour period; it will regenerate automatically at any selected time. During regeneration, the main blower turns off, the alumina is heated to 400C and the moisture laden air is discharged to atmosphere. When regeneration is complete, the operating cycle begins again automatically

---

MANUFACTURER of heat and fluid processing equipment, Selas Corp. of America has completed its move from their former Philadelphia site to a new plant in the suburbs of the same city. This move reflects the expanding markets for heat processing equipment, much of which falls into the classification of automation (See AUTOMATION, January, 1956). Reflecting the specialized engineering requirements associated with heat and fluid processing, the new facilities include a centrally located special laboratory devoted to research and development.

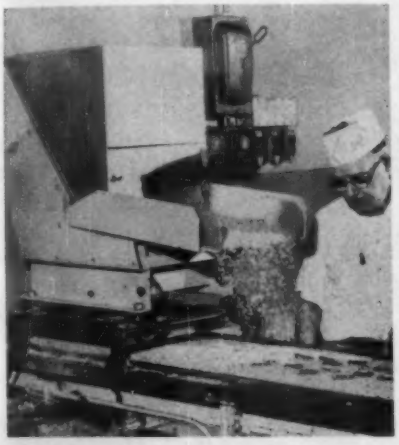
System Logs Plant Data And Monitors Quality

ELECTRONIC system that logs a plant's operating data and adds it up at the end of each day and simultaneously checks on quality has been developed by Minneapolis-Honeywell Regulator Co.

As installed in a refinery, the new system gathers data associated with the production of a commercial solvent, automatically logging such operating data as tem-

perature, pressure, flow, power consumption and product quality. The unit remembers figures for flow and power used and automatically adds these up at the end of each day. It also electronically computes the day's average temperature for a number of critical points. All data, translated into numbers, is fed automatically to electric typewriters, with flow and power measurements also being punched on tape for later use in cost accounting operations.

When not actually recording, the system monitors a number of critical points, keeping track of conditions and picking up any deviations as they arise. Deviations are immediately spotted on an annunciator's panel at an operator's desk.



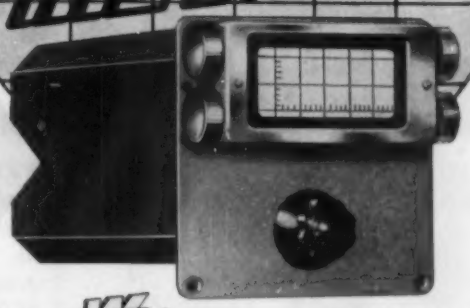
SMALL vibrating feeder called the Velofeeder is manufactured by Richardson Scale Co., Clifton, N. J. from a basic British development. The illustrated unit, powered by a ⅛ hp motor, is used to feed a steady stream of finely ground nuts onto chocolate candy bars as they pass beneath it. Feed rate of the unit is varied by altering the distance between the feed tray and an anvil pad located beneath the tray. The tray is restrained by opposing springs and as it moves forward it is returned suddenly by impact with the anvil pad which is part of a separate spring system that is also vibrating in the direction of the feed. Vibration system is energized by a small rotating eccentric weight.

Instructional Films

FILM on industrial tapes is available for viewing through local "Scotch" brand type distributors or from any Minnesota Mining & Mfg. Co. branch sales office. The color film entitled "Tape It Easy" shows various manual, semiauto-

PANELSCOPE

by Waterman



FOR AUTOMATIC PORTRAYAL

5 POUNDS

ANOTHER EXAMPLE OF Waterman PIONEERING...

The Waterman PANELSCOPE is a custom-built cathode ray tube oscilloscope, with simplified operation, and yet available at a low price. The PANELSCOPE concept provides for the following:

- MINIATURIZATION — Panel space required is only 5¼" x 5-3/16" — depth is 10" and the weight is less than 5 lbs. The PANELSCOPE can be installed in practically any equipment — mobile or stationary air, sea, or land — military or commercial.
- SIMPLICITY OF OPERATION — Twist of a single rotary switch provides a synchronized pattern of desired incoming signal (up to 11 circuits) against proper linear time base. This is ideal for monitoring and trouble shooting, as it removes the need of fiddling with knobs as it is done now on general purpose oscilloscopes. The static controls, such as beam, focus, positioning, and graticule brightness are located in tube escutcheon.
- CUSTOM DESIGN — A wide variety of — signal amplifiers with response from dc to megacycles and sensitivities from 5 millivolts — synchronized or triggered linear time base generators from ½-cycle (and lower if need be) to 2 microseconds — can be specified by you to fit your needs for particular equipment.
- PARTIAL KIT FORM — The PANELSCOPE comes fully wired and tested with chosen signal amplifier, linear time base generator and attendant sync. amplifier. The desired signal attenuators, frequency and amplitude determining components, and method of synchronization can be installed either by us or by you.
- POWER REQUIREMENT — Less than 10 watts of line power for built-in high voltage supply — The required B+ and heater current as selected by your requirements. For those cases where B+ and heater power is not available, auxiliary power pack can be supplied.

There is a place in your equipment for Waterman PANELSCOPE, a custom built oscilloscope at production prices, although your needs may be but one or two. May we have your requirements?

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S-12-C SYSTEMS RAKSCOPE*
S-14-A HIGH GAIN POCKETSCOPE*
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Flat Wire, Machine Wound, Mandrel Wound.

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Preforms in any size or shape that...

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matic and automatic taping machines in action, and is designed to acquaint industry with the time and labor saving advantages of tape automation.

Another film which describes and illustrates the features of construction of the U. S. Multi-Slide and the principles of operation of this machine has been brought out by the U. S. Tool Co. Inc., Ampere, N. J. The film is available for loan to industrial companies, engineering societies, schools and colleges.

Aid To Automatic Brazing

FERROUS and nonferrous metal clad with a predetermined thickness of silver brazing alloy on one or two sides is available from American Silver Co., Flushing, N. Y. Prebonded brazing alloy simplifies automatic brazing operations in that there is no need to insert and position brazing material. With proper heating, a sound joint can be made regardless of the complexity or accessibility of the assembly. The basic strip can be blanked, stamped, rolled, etc., without disturbing the silver brazing alloy which is metallurgically bonded to the base metal.

Handling Equipment Bookings Mark Record Year

INCREASED industrial use of mechanical handling equipment pushed material handling equipment bookings to a record high in 1955, according to the Material Handling Institute. They report that during 1955 bookings were 21.46 per cent higher than 1954. In view of decreased government purchases during the year, the bookings reported represent a 33 per cent increase in material handling bookings for industrial customers.

Manufacturers of handling equipment are forecasting a 10 per cent increase in 1956 over record-breaking 1955 bookings. The forecast is based on anticipated industrial expansion, increased production being planned with existing facilities, and the anticipated labor shortage.

INCREASED activity in the industrial computer field by the General Electric Co. is heralded by a recent organizational move which integrated the company's various computer operations. A new industrial computer section which

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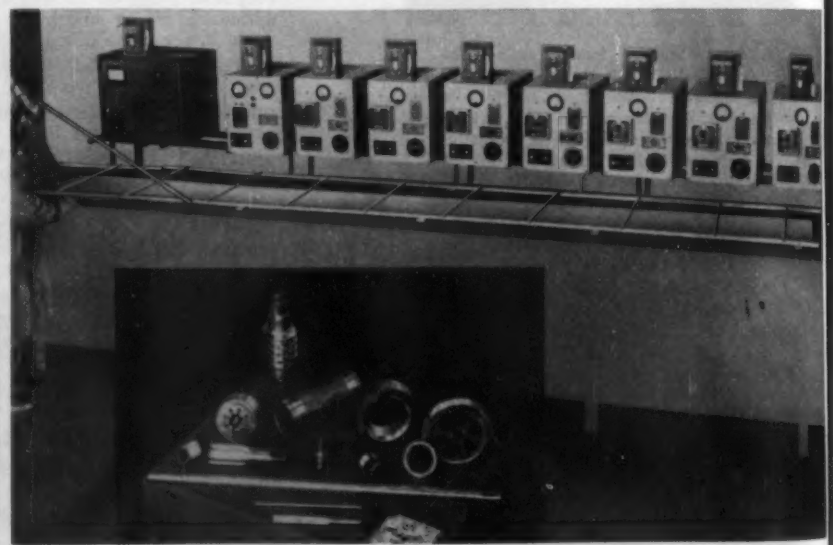
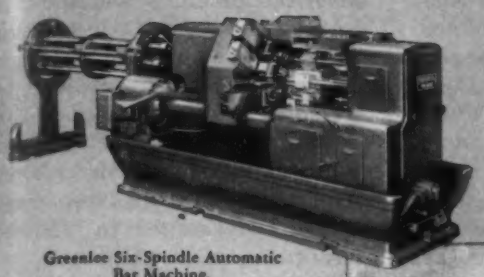


CLOSE CONTROL of time, current density, and solution temperature provide for success in a hard-chrome plating operation capable of maintaining tolerances to within 0.0001 inch. Chrome Electro-Forming Co., Detroit, Mich., engineer and manufacture a complete line of self-contained hard-chrome plating units and have recently expanded this line to include custom models to handle any quantity of parts. The equipment for every unit is fully integrated—with tank size, power, location of anodes and all other components properly related. The dc power is controlled precisely to synchronize with the electro-chemical reaction. A synchronous motor operates the timing controls, and with a density of 2 amp per sq in., chrome is deposited at the rate of 0.000001-inch per minute.

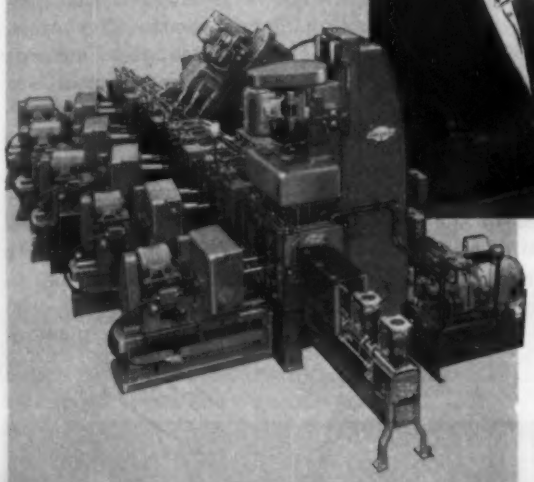


Greenlee Six-Spindle Automatic Bar Machine.

GREENLEE OFFERS

A PROFIT-MAKING INVESTMENT IN HIGH-PRODUCTION MACHINE TOOLS

Greenlee 22-Station Automatic Transfer Machine for machining transmission cases.



Greenlee creative thinking, Greenlee engineering and Greenlee experience combined with that of your own engineers will help you "produce more at lower cost."

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has been established will broaden the computer activities previously based primarily on specialized engineering and military lines.

H. R. Oldfield, Jr., has been ap-

pointed general manager of the industrial computer section. Oldfield was formerly manager of the microwave laboratory at Stanford Industrial Park. He has had extensive managerial experience in the General Electric Co., having previously served as manager of the advanced electronics center and also as manager of plans and product applications in the laboratories department.

Kenneth R. Geiser has been named manager of engineering for the new section, and Clair C. Lasher as manager of marketing. George C. Trotter will be manager of sales.

From today's two primary uses of computers — in engineering mathematics and data processing —General Electric executives see the use spreading to such things as patent searching, stock market transactions, letter-mail handling, bank accounting and the use of computer techniques in advanced mechanization and automation of factory production.

Waste Pickle Liquor Study

EIGHT major companies in the metallurgical industries have announced plans to cosponsor the building and operation of a demonstration plant which is expected to prove a practical solution to the perennial problem of treating and disposing of waste pickling liquors from steel operations. The cooperative undertaking by Blaw-Knox Co., Jones & Laughlin Steel Corp., National Steel Corp., Pittsburgh Steel Co., Republic Steel Corp., United States Steel Corp., Wheeling Steel Co., and Youngstown Sheet & Tube Co. will use a new process designed to regenerate pickling solutions.

A great deal of research has been conducted on the disposal and treatment of pickle liquor, the volume of which is now estimated at more than 600 million gallons per year in the United States. Currently, the predominant method of treatment is by neutralization of the acid content with alkalis and discharging of the resultant sludge into lagoons where the material is dewatered. This is not satisfactory due to high cost and the accumulation of large quantities of sludge presenting a difficult disposal problem.

The Blaw-Knox Ruthner process, which will be demonstrated in the new cosponsored facility, aims at a completely positive answer to this problem by producing only reusable materials with no byproducts. The process, discovered by Othmar Ruthner of Vienna, has been developed and converted to American practices and standards by the Blaw-Knox Co. In this process the entire sulfate equivalent of the waste pickle liquor is regenerated as fresh sulfuric acid for reuse in pickling of steel. The iron in the pickle solution is recovered as essentially pure iron oxide, which is recharged to the blast furnaces.

Rapid Product Changes Emphasize Flexible Equipment

PHARMACEUTICAL industry is faced with an interesting paradox as regards more automatic equipment. It is imperative that production departments of pharmaceutical companies seek methods to maintain a lower overall cost in view of the continuing rise in sales and research cost. But, from the technological standpoint, product advance is often more rapid than the design, fabrication and installation of equipment. An answer suggested by **Dr. John C. L. Blagg,** assistant plant superintendent of the Brooklyn plant of

MAIN console, tabulators and plotters, which are illustrated, are part of the Arnold Engineering Development Center's automatic data reduction system. The system is designed to replace the need of groups of technicians and mathematicians reading hundreds of gages and meters during test operations on jet engines and similar equipment. With the Remington Rand ERA-1102 system directly coupled to the operating engine under test, the data will be recorded automatically and results computed while an item is still being tested. A battery of printers has been installed in a building near the test facility and engineers can immediately tell the reactions achieved in test and can check the results, or intermediate points in the testing program. This type of test installation is expected to result in substantial production economies and will accelerate the development of engines and aircraft.

Chas. Pfizer & Co. Inc., involves flexibility in the design of equipment.

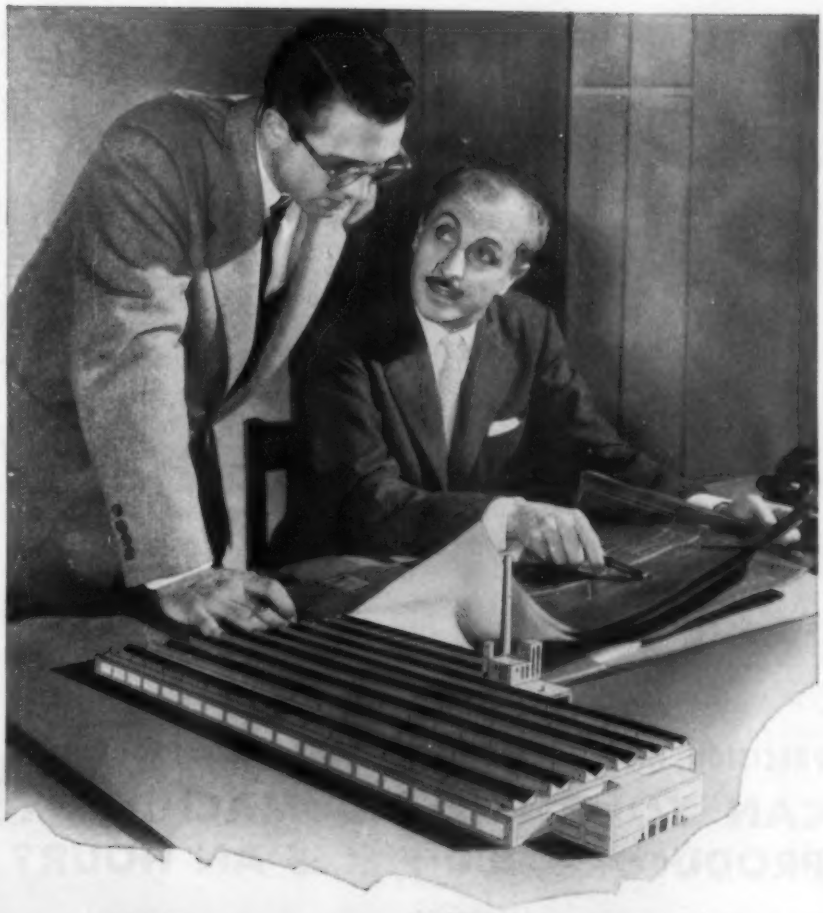
But whatever the answer, the pattern of the industry's growth as directed, shows a natural trend toward automation. The trend shows up in mechanization of ointment filling, elastic capsule manufacture and pill rolling. Continued development of high speed accurate weighing instruments coupled with electronic control devices is especially expected to speed up the automation of tablet manufacturing.

Speaking at a meeting of the American Pharmaceutical Manufacturers Association, he pointed out that many larger tablet producers have already organized their production on a continuous basis from mixing through granulation, drying, milling, compression, counting and final packaging. It is but a small step further to automatic control where feedback from a control instrument would correct variances and eliminate human error.

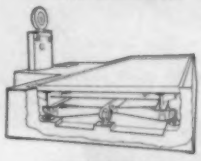
NEW president of Feedback Controls Inc. is **William M. Pease,** formerly vice-president and general manager. Pease has also served as vice-president and manager of the Electronics Div. of Ultrasonics Corp. and director of the Servomechanisms Laboratory at M.I.T. In the latter position he was instrumental in development of the M.I.T. numerically controlled milling machine.

Information on Electron Tubes Available From NBS

TUBE information service for accumulating and disseminating technical data on both domestic and foreign radio tubes has been established by the National Bureau of Standards. Nearly 10,000 cards, filed by tube type number, are appropriately referenced to manufacturers source material. In addition, about 10 per cent of these cards, selected mainly from the high-use miniature and subminiature types, have been coded on punched cards for mechanical sorting. Recently, junction diodes



When you STUDY COSTS it pays to take a plant-wide look at WEIGHING



WEIGHING

COUNTING

ELECTRONIC RECORDING

TESTING

A MODERN WEIGHING SYSTEM can make a big difference in cost control and profit in your plant!

Are scales missing where needed? Are over-worked scales making bottle necks in your production? Are you losing material and time with scales misfitted to their jobs? In this day of highly specialized machines and methods, your scales should add up to a *Weighing System* . . . the right scales in the right places . . . supplying basic data for your accounting *system*. These records that originate at scales directly affect costs, inventories and customer billings. Weighing today is not a job for isolated scales—it's a vital part of your overall cost-control system.

If you would like to look further into this in your plant, why not drop us a line today? No obligation, of course. Ask for Booklet 2036. Toledo Scale Company, Toledo 1, Ohio.

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STANDARDIZED AUTOMATION!

Standard 12 stop Intermittor with specially jig-bored 36" dial.

PRECISION INDEX TABLES FOR HIGH SPEED PRODUCTION

CAN YOUR PRESENT MACHINERY PRODUCE 30,000 PIECES AN HOUR?

Few production machines can . . . but it's possible with the Ferguson Intermittor Index Table. There are models capable of 30,000 indexes an hour if your machinery and tooling can keep up with them. The point is . . . *the Intermittor does not limit the speed of your machinery the way geneva driven or air or hydraulic operated tables do.*

Perhaps speed is not your problem, but excessive maintenance costs are . . . resulting from the clanging, banging and jarring you get from a geneva drive. Here again you find the solution in an Intermittor. Employing modified trapizoid acceleration characteristics, the Intermittor has an initial acceleration point of zero with a gradual increase to the maximum and an equally gradual decrease to zero again . . . *all of which means that the Intermittor is a smooth operating table with minimum shock and vibration.*

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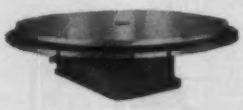
There are many more reasons why you should install an Intermittor when you need a rotary table for large volume production, including the fact that you can select one of 150 standard models from a catalog and get exactly what you need in terms of dial size, number of stations and indexing period.

OVER 150 STANDARD MODELS TO CHOOSE FROM:

Standard 24 station Intermittor with 30" dial and optional stationary tooling plate above the dial.

6 station Intermittor with 12" dial and special tool mounting brackets.



Standard 18 station Intermittor with 48" dial.

Send for our Catalog No. 300 . . . it has a definite place in your file if you have the responsibility of speeding up production or converting to automation.

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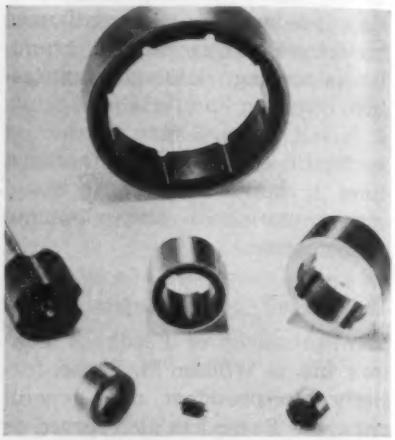
and transistors have been added to this program.

With this unique service, it is possible to find information about any particular tube; all tube types whose electrical characteristics, bulb sizes or base configurations fall within particular ranges; and domestic tubes that can be substituted for unavailable foreign tubes.

The Bureau service is open to all who have legitimate requests. Manufacturers are urged to supply the Bureau with technical information on new tube types as they are placed on the market, so that the service can include all the most recent data.



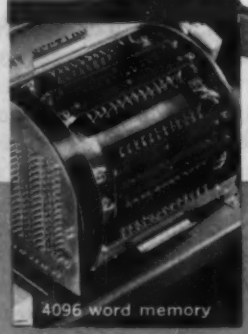
PRESSED plastic-bound permanent magnets, having been used successfully in Germany, are now available to manufacturers through the Baermann-Nord Corp., Amherst, O. The method of manufacture makes it possible to press shafts, temperature compensation pieces and bearings right into the magnets or to make magnets of advantageous but intricate designs on a mass production basis which would be difficult and uneconomical with cast or sintered magnets. The need for machining operations is eliminated.

FORMATION of two new companies, Taylor Devices Inc., a manufacturing company, and Tayco Developments Inc., a research company, has been announced by **Paul H. Taylor,** president. Both companies are located in N. Tonawanda, N. Y., and have been established to manufacture and develop compressible material devices utilizing the unique compressibility of special liquids. Liqui Spring-Shoks and Liqui Springs are names of two devices developed by the companies. Developments indicate that the Liqui Spring-Shok can replace

the new approach to large scale computations in automatic systems design!

LGP*30

THE NEW LIBRASCOPE GENERAL PURPOSE COMPUTER



4096 word memory

SPECIFICATIONS:

Word length:
30 bits, and sign
Mode of Operation:
Serial, one address
Program Storage:
Internal
Access time:
8.5 ms av. 2 ms min.
Transfer time:
1 ms min, 17 ms max.
+ time: .26 ms
+ × time: 17 ms
Power: 1500 Watts

One word defines the "new approach" of the LGP-30...SIMPLICITY. *Operating Simplicity*...for the average engineer...made possible by the elimination of non-essential commands. Programming techniques are easily mastered. *Design simplicity*...that results in complete mobility. The LGP-30 may be operated from any 115 Volt AC outlet. *Service simplicity*...because fewer components, conservatively operated, mean less "time-out" for maintenance. And, too, the LGP-30 costs considerably less than any other general purpose computer—to buy and operate.

Write for brochure describing applications, operation and detailed specifications.

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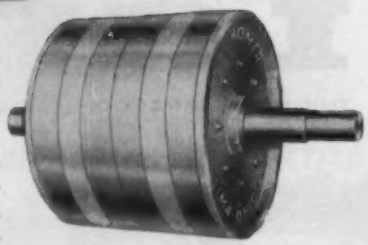
PERMANENT MAGNETIC EQUIPMENT FOR METALWORKING PLANTS

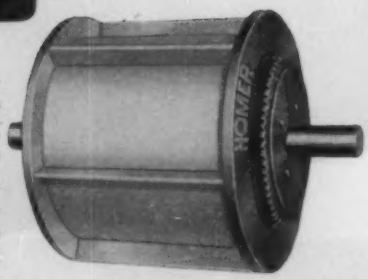
SAVE TIME . . . MONEY . . . LABOR

HOMER *HERCULES* AND *HERCULES*-SUPREME PERMANENT MAGNETIC PULLEYS



Homer Permanent Magnetic Pulleys in belt conveying systems cut costs in a multitude of metalworking operations. They automatically remove tramp iron from coke, slag, ores, foundry sand, etc. . . . sort ferrous from non-ferrous parts . . . and segregate ferrous from non-ferrous materials, minerals, etc. Trouble-free with no D.C. power supply required—no production stoppages as result of power failure. Homer's "Radial Pole Design" assures highest magnetic strength across entire working face of pulley for deep, effective penetration and positive control of magnetic materials. Write for Bulletin PY-260.

HOMER PERMANENT MAGNETIC DRUMS



Homer Magnetic Drums automatically and economically beneficiate ores . . . remove tramp iron from slag, coke, foundry sand, ores, etc. . . . and separate ferrous parts from abrasive material following tumbling barrel operations. For installation at discharge end of gravity, screw or belt conveying systems and for use with tumbling barrels. Permanent, non-electric and trouble-free—Homer Magnetic Drums require no outside power source. Homer's "Radial Pole Design," with permanence of magnetic strength guaranteed, assures maximum effectiveness at all times. Complete details in Bulletin MD-200. Write for it today.

OTHER HOMER PERMANENT MAGNETIC EQUIPMENT FOR INDUSTRY

HOMER MAGNETIC ROAD AND FLOOR SWEEPERS
Write for Bulletin MS-250

HOMER "SPACE SAVER" MAGNETIC CONVEYORS
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HOMER MAGNETIC SHEET SEPARATORS
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THE FINEST IN PERMANENT MAGNETIC EQUIPMENT FOR INDUSTRY

both vehicle springs and shock absorbers by combining their actions into one compact unit. Applications of Liqui Springs are in metal working dies, packaging, machine tool and automation devices.

AUTOMATIC screw feeder that eliminates hand placing of screws enables one person to perform a fastening operation in half the time formerly required by two persons. The screw feeder, a product of Pneuma-Serve Inc., Cleveland, O., can be adapted to special problems where cross threading is a possibility. Special double foot, attached to the head of the driver, prevents blunt machine screws from tilting, and thus causing cross threading while being driven into a phenolic fiber terminal board.

GOVERNMENT of India has elected **John D. Elliott,** representative of the Cross Co., to serve as an advisor to its machine tool committee. Elliott will review India's present machine tool capacity and requirements and its facilities for developing machine tool designers, and make recommendations to expedite machine tool deliveries as to size and scope of new factories.

MEETINGS AND EVENTS

April 9-12—

American Management Association. Twenty-fifth National Packaging Exposition and Conference to be held Convention Hall, Atlantic City, N. J. Additional information may be obtained from Associa-

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Vickers complete Magnetic Amplifier Systems are developed to meet the need for reliable and accurate control in today's rapidly-expanding field of automatic control in industry.

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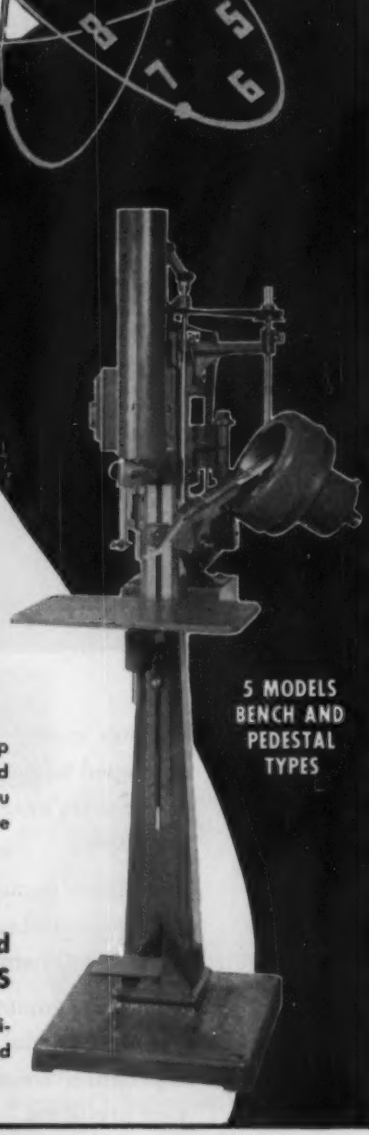
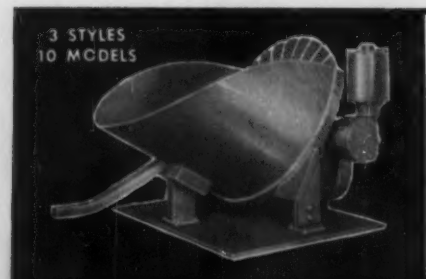
And remember, D.P.S. specially trained engineers are ready to tackle your problem and come up with the right answer





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tion Headquarters, 330 West 42nd St., New York 36, N. Y.

April 18-20—

Illinois Institute of Technology. Armour Research Foundation sponsored conference on industrial research to be held on university campus. Additional information may be obtained from Illinois Institute of Technology, 35 West 33rd St., Technology Center, Chicago 16, Ill.

April 26-27—

American Institute of Electrical Engineers. Conference on recording and controlling instruments to be held Bradford Hotel, Boston. Additional information may be obtained from Institute Headquarters, 33 West 39th St., New York 18, N. Y.

May 9-11—

American Material Handling Society. Western Material Handling Show and conference to be held Western Livestock Exhibit Bldg., Los Angeles. Additional information may be obtained from Public Relations Director, 1501 Oregon Ave., Long Beach 13, Calif.

May 7-11—

American Welding Society. Fourth Welding Show and conference to be held Memorial Auditorium, Buffalo, N. Y. Additional information may be obtained from Society Headquarters, 33 West 39th St., New York 18, N. Y.

May 9-19—

Mechanical Handling Exhibition and Convention. To be held Earls Court, London, England. Additional information may be obtained from exhibition manager, Dorset House, Stamford St., London, S.E. 1, England.

May 14-17—

American Society of Mechanical Engineers. Design Engineering show to be held Convention Hall, Philadelphia. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

May 21-22—

Radio — Electronics — Television Manufacturers Association. Symposium on reliable applications of

electron tubes to be held Irvine Auditorium, University of Pennsylvania, Philadelphia. Additional information may be obtained from Association Headquarters, 650 Salmon Tower, 11 West 42nd St., New York 36, N. Y.

May 24-25—

Third Conference on Mechanisms. Sponsored by Purdue School of Mechanical Engineering and *Machine Design* to be held Purdue University. Additional information may be obtained from the Editor, *Machine Design,* Penton Bldg., Cleveland 13, O.

June 5-8—

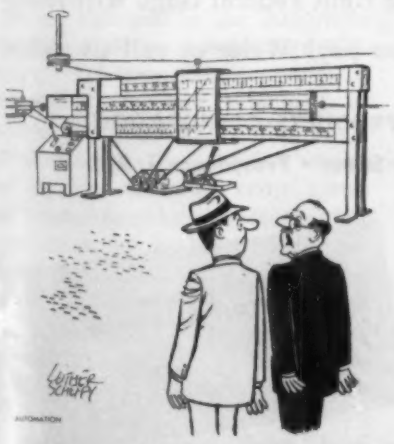
Material Handling Institute Inc. 1956 Exposition to be held Public Auditorium, Cleveland. Additional information may be obtained from Institute offices, Suite 759, One Gateway Center, Pittsburgh 22, Pa.

June 11-15—

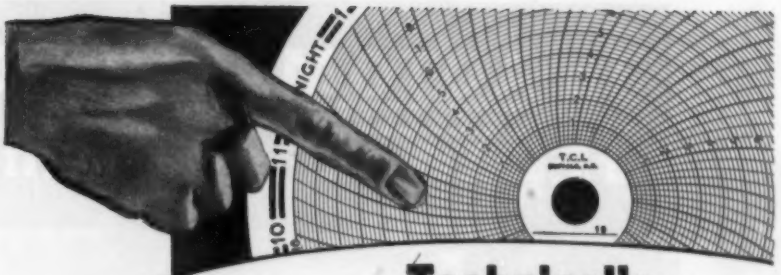
Society of the Plastics Industry Inc. Seventh national plastics exposition to be held new Coliseum, New York. Additional information may be obtained from Society Headquarters, 65 West 44th St., New York 36, N. Y.

June 11-29—

Case Institute of Technology. Summer study course in process control theory with frequency techniques to be held Cleveland campus. Additional information may be obtained from Graduate Div., Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, O.



"We're new in the computer field, so we just have to feel our way along."



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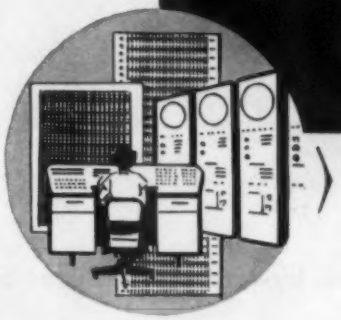

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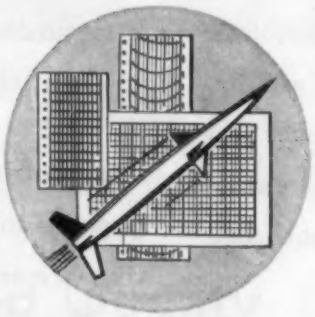

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for new instruments or unusual process needs!

Charts are vital to the **new recording instrument** design. Be sure you contact **Technical** when your project begins and eliminate recording problems at the start! For standard instruments recording under unusual process conditions, **Technical** can supply "Special" charts on heat or electro sensitive and other papers. Send for "Technical Notes" containing helpful new chart specifications.

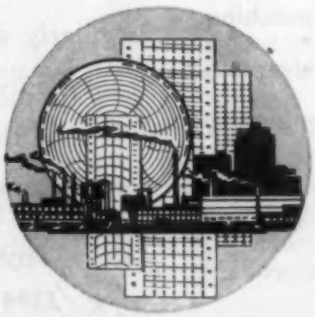

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Chart supply is easy . . . and operating costs are less . . . when you suggest to your purchasing men to buy **all** their chart needs from **Technical. Technical's** acceptance by large and small "Blue Chip" companies is testimony of high chart quality. Automatic order processing and inventory control assure fast service. Write for Catalog 56 and stock list.

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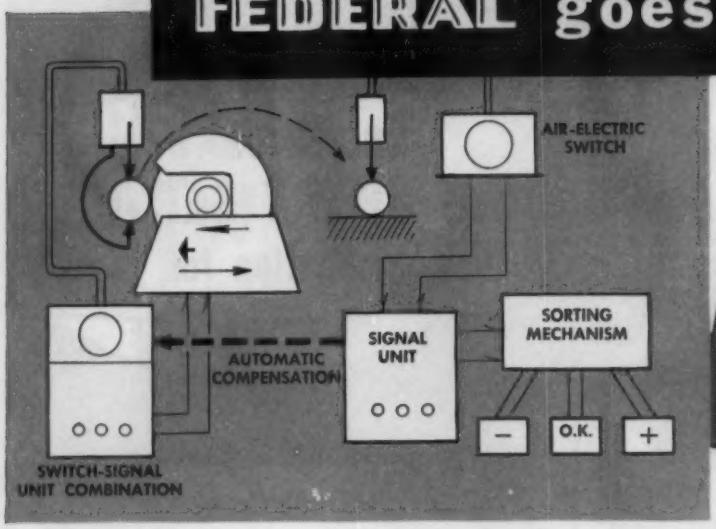
In AUTOMATION Gaging, too, FEDERAL goes the whole way



Ask for your copy!

The new Federal Automation Catalog includes many photographs and diagrams showing automatic gaging systems successfully employed in various industries. Full of valuable ideas — an important reference book. Free on request.

Automation has become a fashionable byword in plants today. It's easy to look upon Automation as the answer to every production problem. Being the first to treat Automatic Gaging so fully, however, we are well aware that mistakes and disappointments often occur when complete automation is undertaken with insufficient knowledge and too hasty planning.

We work closely and successfully with machine tool builders to develop gages that conform to the capabilities of their machines. Our engineers provide various degrees of control on existing machines in the field and also work in close collaboration with machine designers to provide gaging and control units built into the manufacturer's original machines.

We have many highly successful installations in daily operation and will welcome the opportunity to discuss your proposed automation when you first start your preliminary planning.

Our goal is the development of the one best gage for any job, in the fastest time, at the lowest cost. We are widely experienced in mechanical, air, electric, and electronic gages . . . and are regularly designing and building them all. If gaging in your plant can be automated, chances are good that the right Federal Gage will really make Automation pay! Write or call us today.

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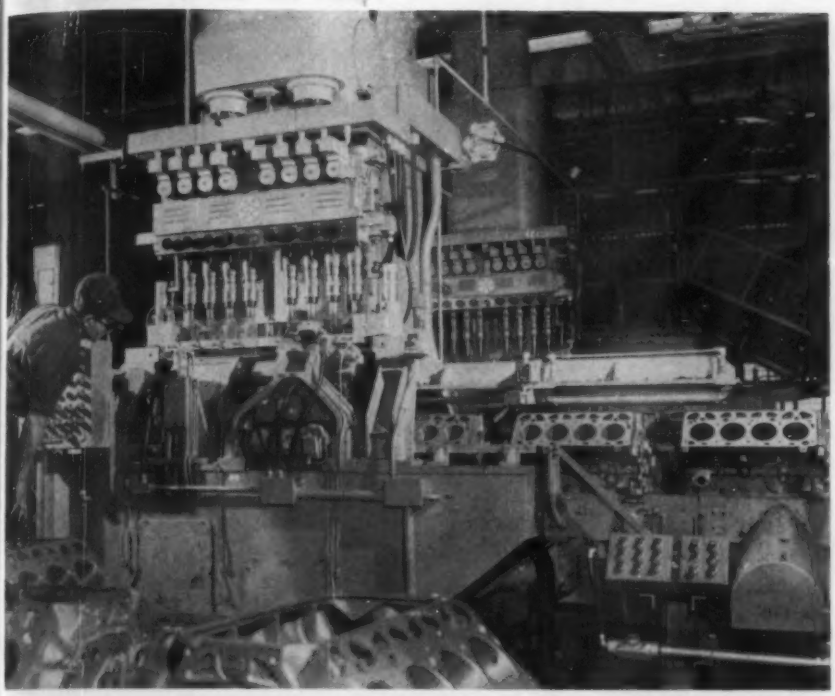
FOR RECOMMENDATIONS IN MODERN GAGES . . .
Dial Indicating, Air, Electric, or Electronic—for Inspecting, Measuring, Sorting, or Automation Gaging

By JAMES C. KEEBLER
Associate Editor



Micromatic honing machines put the finishing touches on cylinder bores in Ford V-8 engine blocks to give them the highly finished surface required for a proper assembly. The cylinder blocks are tilted so that the machine may hone the cylinder bores in a vertical motion. The block is then transferred to the next station and the tilting action is reversed so that the second bank of cylinder bores also is honed vertically.

Gaging Automated Quality

SPEED of production continues to rise with each new improvement in machine tools and production techniques.

In an address to the American Tool Distributors Association, William C. Newberg, vice president of Chrysler Corp. and president of Dodge Div. highlighted this rapid advancement. ". . . How many people, for instance, know about the tremendous improvements that have been made in virtually all kinds of metalcutting machine tools over the past ten years? You and I know that some present-day lathes are turning fifteen times faster than those in use before World War II.

"Similar advances have been made in pressing and stamping. Only six years ago most big presses were capable of turning out large stampings at the rate of approximately six strokes a minute. Today there are big presses with new automatic materials handling devices which can operate all day long at eighteen strokes a minute or better. This is a spectacular gain of at least three to one since 1949.

"Besides operating at higher speeds and performing in ways that were unheard of only a few years ago, machine tools are now working metal to far closer tolerances than were formerly possible ....."

Making Good Ones

As production speeds are increased it is only natural that the automakers' concern for quality should increase too. Despite the fact that automatic cycling machines are considered to be more accurate than hand operated equipment (no matter how hard you push the button—the same thing happens), the automation engineer's nightmare is that his machines might start making scrap parts automatically at a tremendous rate.

This fear can give him headaches with various kinds of pain. If an operator attempts to load an offsize part into a fixture whose locator will not accept the part, he has in effect performed a gaging operation. But with automatic equipment the story is different. If offsize parts are not previously sorted out, an automatic loader will jam and result in costly downtime.

Missed operations, if not detected, can cause cutting tool breakage at a subsequent station. Failure of a part to eject from a die can cause a double hit that might crackup the press. Out-of-tolerance parts at the end of the line can shutdown assembly operations.

This points to the need for additional gaging operations to be the watch dog on product quality as well as equipment and operator safety.

To keep pace with these fast moving machine tools the gagemakers are called upon to supply automatic gaging machines that quickly measure the parts, sort them and even control machine tool setting by signaling the trend of size change.

This means more air gages and fewer fixed size hand gages, more master setting gages and standard size blocks that establish and maintain zero settings on complex gaging machines.

The complexity of this gaging equipment means that no longer can the master mechanic leave his gage planning program go till last. Design and procurement time for these vital sentinels often puts

them in the same flow time brackets as the machine tools themselves.

Gage planning now ranks with machine tool planning in the establishment of the automated manufacturing process.

Right on the Button

The automaker not only demands speed in his gaging operations, but ever increasing accuracy as well. The gage must continually be more precise than the machine tool or it loses its value as the guardian of machine performance. If you can't trust your gage to measure to closer tolerances than your tools can produce you need a better gage.

High levels of inspection accuracy lead us to an interesting phase of mass production so far as automobile engines are concerned. Mass production's cornerstone is the principle of full interchangeability. Yet if parts can be measured to closer tolerances than they can be economically produced, it is possible to resort to noninterchangeable manufacture—selective fitting — and assemble parts to closer fit limits than would otherwise be possible.

Choose Your Partners

Ford V-8 engines provide an example of mass production where quality is improved by selective fitting parts for assembly. Cylinder bores that are accurately honed for size and finish are classified into 8 steps of 0.0002-inch tolerance and pistons are similarly grouped to achieve proper fit.

Crankshaft journals that fit the connecting rods are each classified into one of two steps of 0.0002-inch tolerance. This means that as the crankshaft is assembled to the engine the combinations of piston and connecting rod assemblies required to fit the four throws of the crankshaft and the eight cylinder bores are visible by previously gaged markings on the parts.

The possible combinations required here sound like confusion galore, but Ford uses an automated communication and handling system to keep the record straight and the quality high.

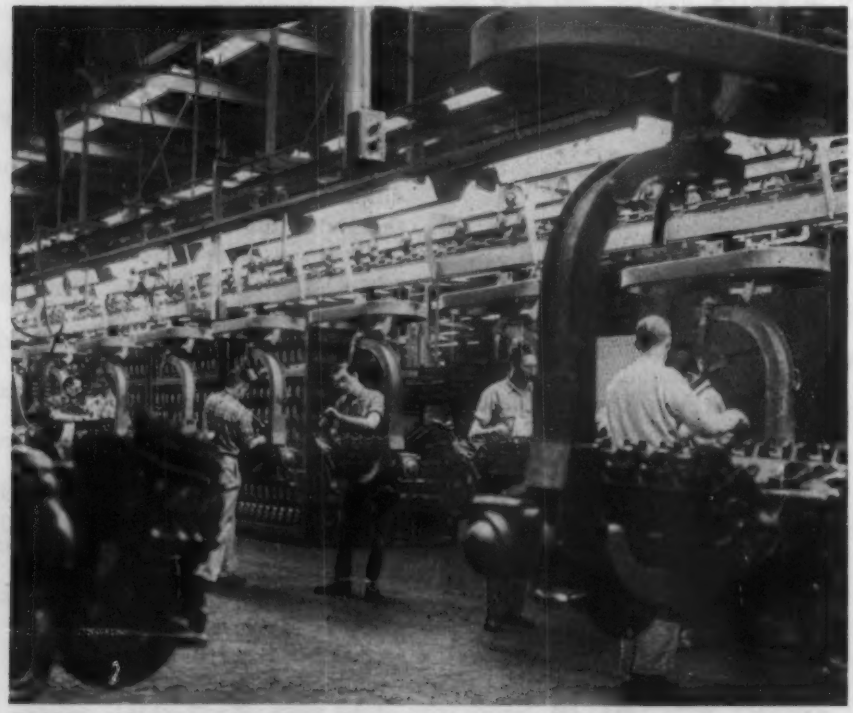
Known as TelAutograph, the communication system has a sending station at the beginning of the engine assembly line, and three receiving units at strategic locations in the plant where engine components are placed on conveyors for delivery to engine assemblers.

Inspectors stationed at the start of the assembly line use air gages to determine the exact size of each of the eight cylinders in the new engine. They also classify the crankshaft dimensions. This information and the engine identification number are written by hand on the TelAutograph, which transmits the instruction to a worker at the piston selector rack, to an inspector, and to a connecting rod assembler.

Pistons are selected to match the dimensions of each engine's cylinder bores and are hung on a conveyor rack. Inserts are put in the connecting rods to size them exactly in accordance with the crankshaft journal measurements.

Therefore each piston and connecting rod assembly is made up especially for a cylinder bore and is so identified in the conveyor rack that takes these matched sets to the assembly lines. These parts reach the engine assembly line shortly before the matching engine block gets to the assembly station. When the right engine comes along, the matched set of pistons and connecting rods is installed.

The TelAutograph system makes it unnecessary to have large stocks of various size pistons and connecting rods alongside the engine assembly line, and reduces the possibility of wrong selection while the engines are being assembled.



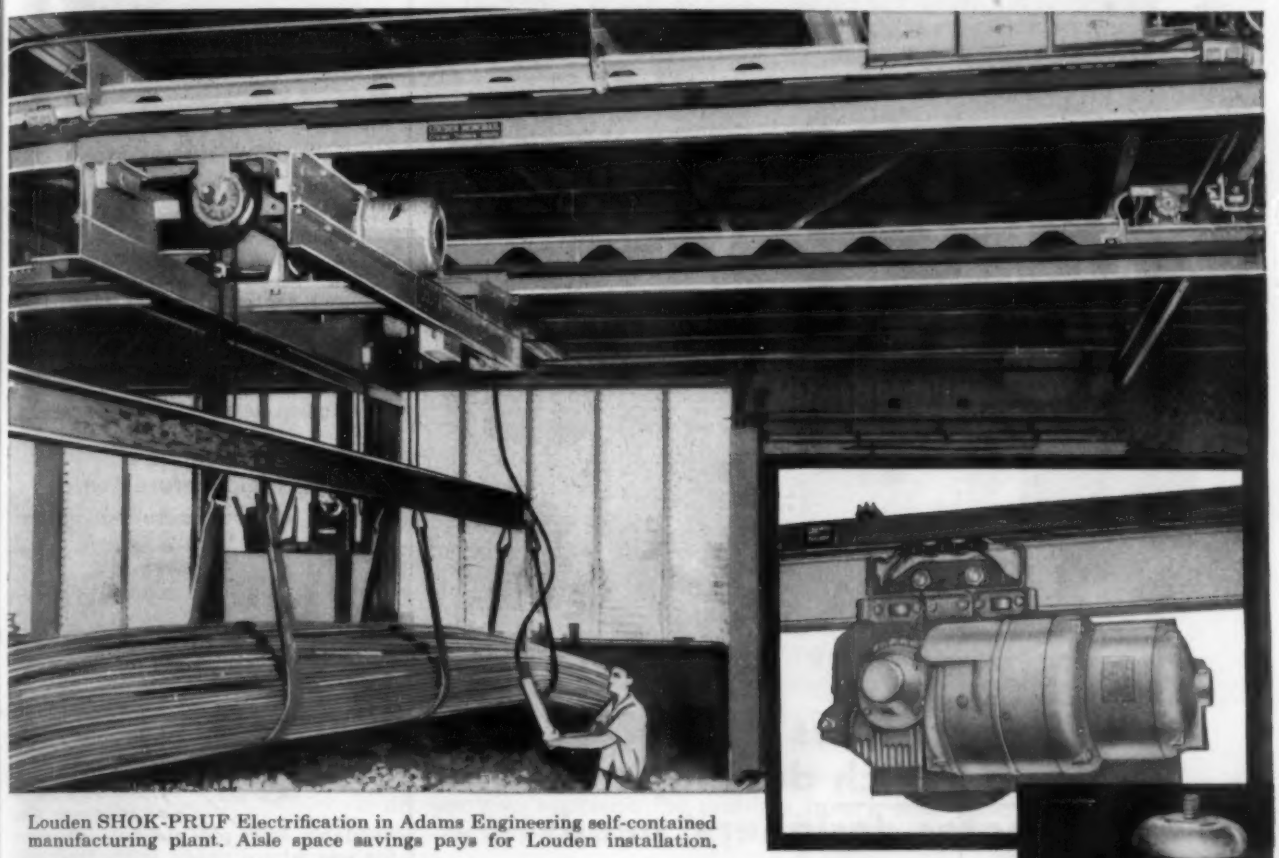
Overhead steel arms carry Ford V-8 engines through assembly operations at a height convenient for assemblers. Engines are attached to the carrier at the start of assembly operations and remain on the steel arm through all assembly, testing and repair operations. Selective-fit pistons and connecting rods reach the line in timed sequence so that matched sets are ready as each engine comes along.

Precise Precision

At first glance it might appear that when the machine tools of tomorrow can make all parts to a total tolerance of 0.0002 the selective fitting procedures will be obsolete. But the observer can't help but wonder if then the gagemakers will be in a position to provide equipment that will have the automakers' classifying in steps of 0.00002-inch.

In any event gage accuracy is a key to automaking quality.

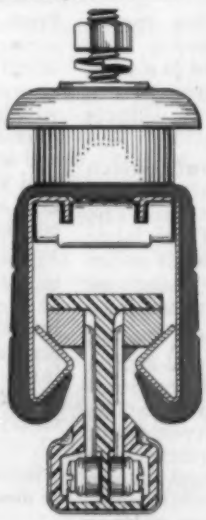
LOUDEN *SHOK-PRUF* ELECTRIFICATION makes good handling installations better



Louden SHOK-PRUF Electrification in Adams Engineering self-contained manufacturing plant. Aisle space savings pays for Louden installation.

Exposed conductor bars are a hazard to men working about a plant. There is only one way to eliminate the risk . . . by providing an effective insulation barrier . . . Louden Shok-Pruf Enclosed Electrification. The Shok-Pruf scheme completely isolates and insulates the conductor bar, completely covering it on all sides with heavy, tough and durable Neoprene. The only opening to the conductor bars is a narrow channel at the bottom through which the arm of the current collector passes. The wrap-around insulation prevents any possible contact and removes all hazards. Workmen welcome this protection and work efficiency increases at once. Safety records improve; insurance costs go down. A typical Louden Shok-Pruf installation is the plant of the Adams Engineering Company, Miami, Florida, makers of aluminum lawn and porch furniture. Shok-Pruf is another development typical of Louden broad-range engineering experience, knowledge and equipment that turn to fullest account the fundamental advantages of overhead handling. Shok-Pruf Electrification is available for *any* crane or monorail installation. Consult a Louden representative. Write, phone or wire today.

Close-up of SHOK-PRUF insulated conductor bar, current collector and Louden Moto Veyor drive unit.



Side view of SHOK-PRUF channel type conductor bar.

Cross-section SHOK-PRUF conductor bar and collector.

1 Neoprene insulation.

2 Heavy zinc-coated steel conductor.

3 Multiple, articulated collector shoes give greater contact surface, are self-cleaning, eliminate arcing, give up to 10 times longer life.

4 Articulated collector overcomes misalignment at transfer points.

Louden

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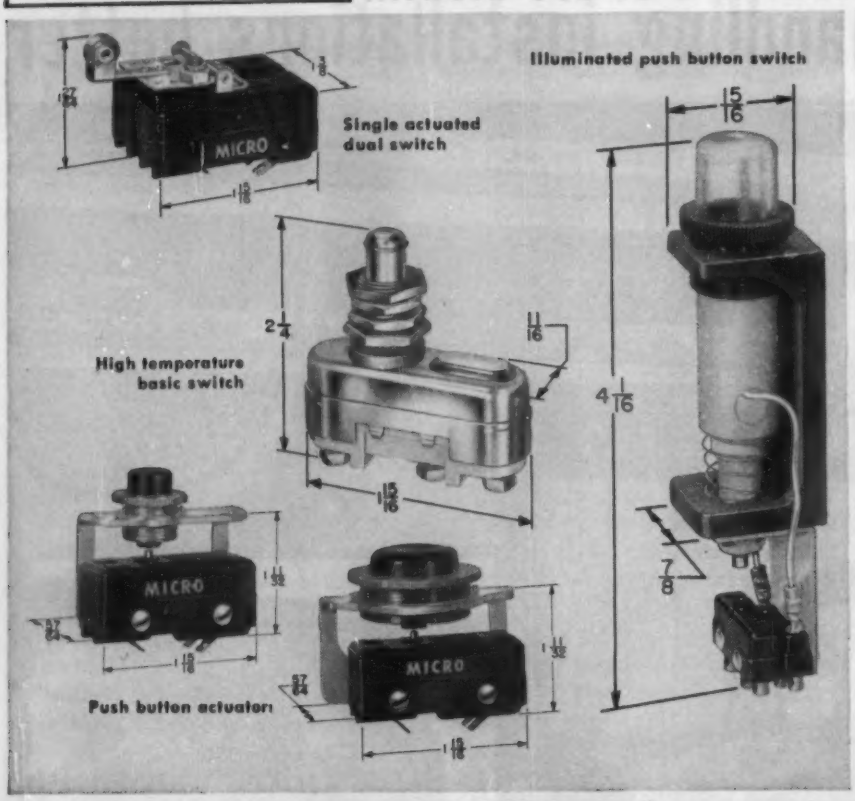
MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



A continuous flow of Precision Switch developments anticipates designers' needs

Function of MICRO SWITCH Engineering, both at the factory and in the field, is to supply the precision switch which most exactly meets the design requirement.

Shown here are just a few recent MICRO SWITCH developments that designers have found useful in a wide variety of applications. Write to any branch office or to Freeport, Illinois for more detailed information.

The Single Actuated Dual Switch consists of two basic switching units operated by a roller lever actuator. The operating point of one of the basic switches is field adjustable so either simultaneous actuation or a definite sequence of operations is possible.

The Illuminated Push Button Switch is a low force, high pre-travel switch with an indicating light as an integral part of the push button. The high pre-travel permits movement of the button before the contacts snap over. This switch is designed for use in electronic, aircraft, mobile, marine, railway and other low voltage a-c or d-c applications.

The High Temperature Basic Switch is a precision snap-action switch which will operate satisfactorily in a temperature range of from −50° to plus 1000° F. It is useful in such industrial applications as found in distilleries, foundries, vulcanizing plants and other industries which require high temperature components.

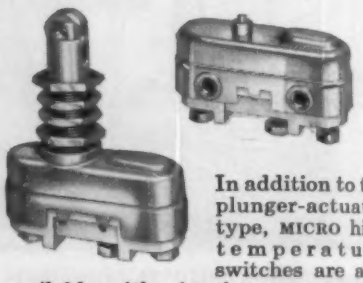
Push Button Actuators are of a new series available to designers of electrical computers and other types of commercial and industrial devices which require reliable panel-mounted, manually-operated switches. They are available with ½" or 1" buttons and combine attractive appearance and extremely long life with an exceptionally good actuation "feel".

Manufacture of precision switches is not a side line with MICRO SWITCH. It is our entire *business*. That is why industrial designers come to us more and more each year with switch problems of amazingly diverse types. MICRO SWITCH branches are conveniently located to serve you.

Illuminated Push Button Switches allow mounting on one inch centers

MICRO SWITCH Illuminated Push Button Switches are outstanding for ease of operation, high pre-travel, compact design (which permits mounting on one inch centers), smooth appearance and easy-to-see pilot light. Switches are provided with sockets for a single contact miniature bayonet lamp. Removable translucent push buttons are available in clear, red, or frosted white.

High Temperature Switch comes in three actuator types



In addition to the plunger-actuator type, MICRO high temperature switches are also available with pin plunger actuators for use where space is limited and small operating motion is available. Roller plunger actuators are provided for applications where cam or slide action is required.

How Push Button Actuators are mounted to a panel

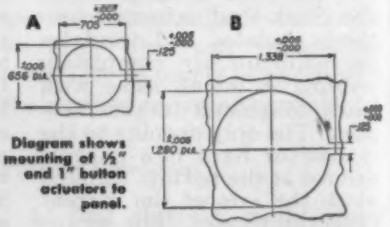


Diagram shows mounting of ½" and 1" button actuators to panel.

Knurled bushing assembly is inserted through the panel and threaded into the switch mounting bracket. The mounting bracket in turn is keyed to the panel, using Mounting details A or B.

MICRO SWITCH Engineering Service is available to help you select the exact switch to meet your design problem. Call the MICRO SWITCH branch nearest you.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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Know Your Operations

It has been disconcerting to note the number of instances of haphazard advance into more automatic operations. Not infrequently the equipment builder is faced with continuously changing specifications or requests for additional features on completing a special machine. All too often there is evidence of little thorough planning.

Today, much can be done with automation. It is imperative, however, to make a careful study of operations and know the facts. Studies can establish definitely how far the operations should be carried; what real savings can be made; what production speeds can be attained; and whether improved functional characteristics of the automatically produced product will warrant automation.

When planning is haphazard or meager, results are seldom what they should be, and costs are always higher.

Methods men of yesterday sought merely to determine whether a given motion was really necessary; to reduce all industrial work to standardized bits and pieces; concentration was on motions and their elimination or reduction to simplest form. Good management and the automation engineer today must make a clean break with these doctrines of the past which evolved basically around human limitations. For automation it is necessary to approach the problem from a new, more comprehensive viewpoint:

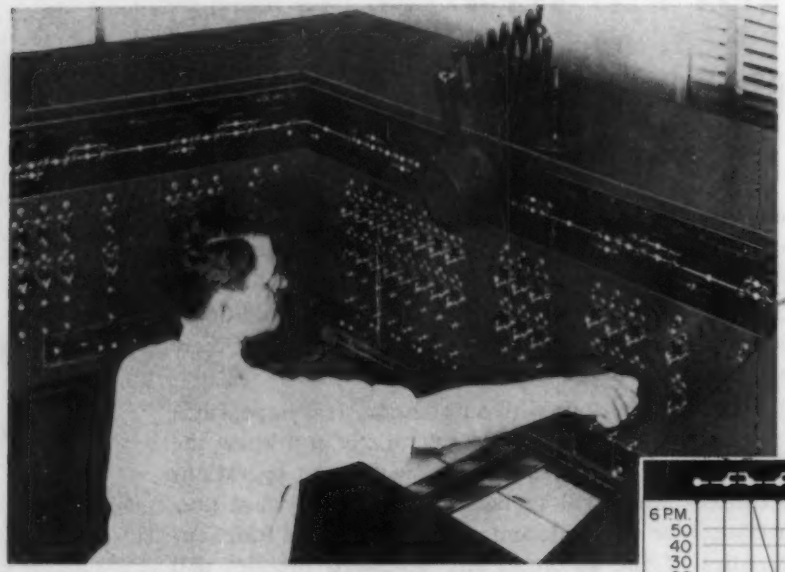
First, consider the product to be produced. Are the detail design features such as to make it most amenable to automatic manufacture?

Second, consider the various manufacturing methods involved. Are they the best? . . . the most economical? . . . will product modification permit improvement?

Third, consider the individual operations required for the complete manufacturing cycle. Are all really needed? . . . are they in the right sequence? . . . should they be done by automatic machines? . . . can all or part of the automatic operations be linked together to get automatic production?

Start with one project of an overall plan, work it over carefully and completely and see what thoroughly planned automation techniques can do for you!

EDITOR



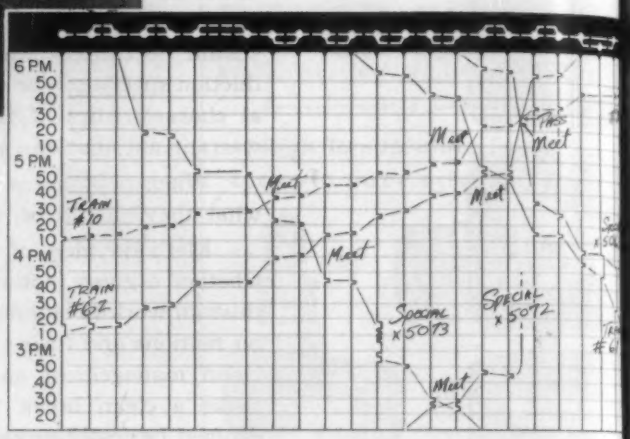


Fig. 1—Control machine for centralized traffic control. Condition of lights on track model reflect movement of trains, position of switches, and signals at each controlled point. Automatic train graph provides permanent record of train movement through the controlled territory

RAILROAD EXPERIENCE HIGHLIGHTS SUCCESSFUL

RELAY CONTROL SYSTEMS

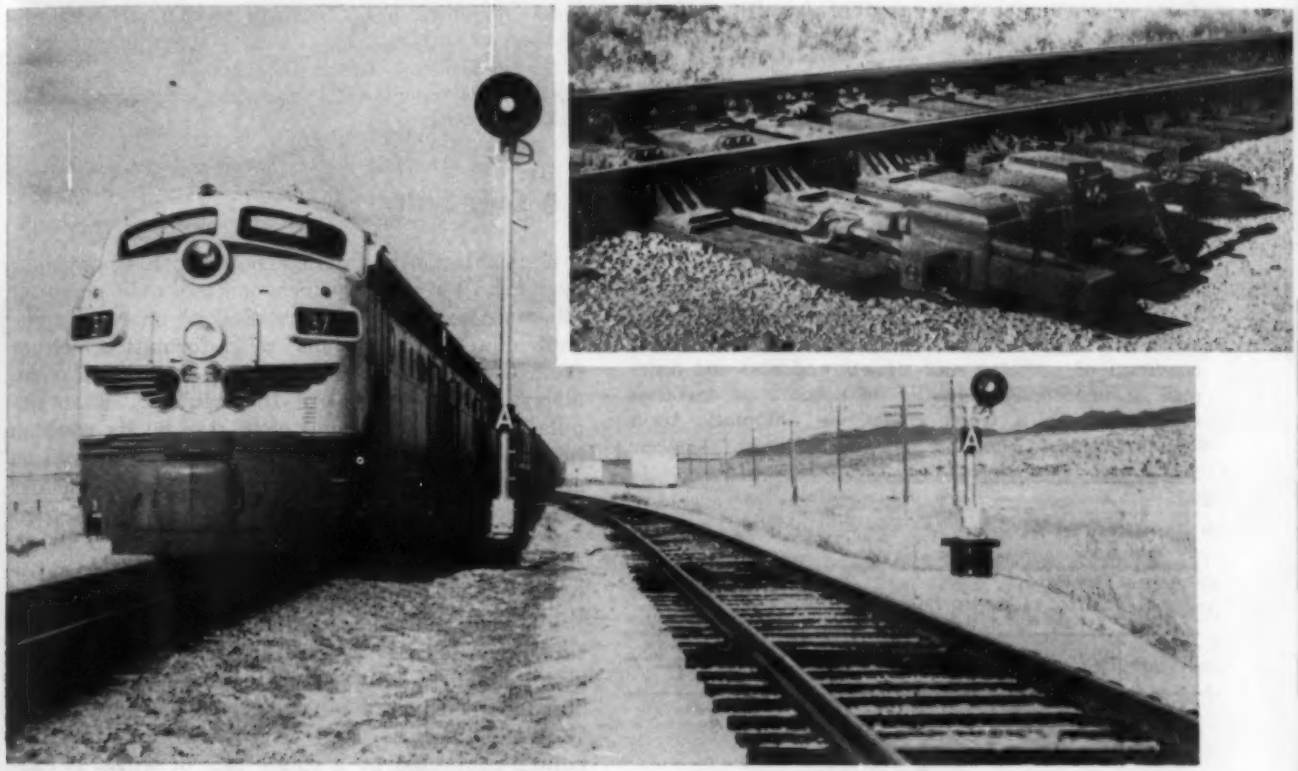
By J. H. McRAINEY
Assistant Editor

Every fact that is learned becomes a key to other facts—a homely observation but extremely meaningful to a technology such as automation that embraces all industrial fields. This article is concerned with a general discussion of basic techniques and practices associated with a practical and well proved relay control system developed by the railroad industry for traffic control.

CENTRALIZED traffic control as applied to the railroad industry is among the many fine examples of successful automation which predate the use of the word itself. In railroad transportation, as in other fields of transportation, the factors of safety, dependability of operation, and maintainability of equipment have been and are of paramount importance. Major characteristics of all equipment put into use by the industry must reflect such factors to a high degree.

In view of these exacting standards which reflect the requirements of automation in all fields, it is of considerable current interest to note that centralized traffic control (CTC) in the railroad industry involves a complex system of mechanical, electrical, and pneumatic elements that has successfully served the railroad industry for over 25 years. The addition of electronic elements to

Fig. 2—Each controlled location is provided with a small relay house containing field equipment, various signals to guide train operator, and necessary switch machines located next to tracks.



the basic system dates back to 1942 and is representative of continual improvements which has resulted in industry acceptance of larger and more extensive applications.

Knowledge of these successful early forms of automation is of importance other than from the historical viewpoint. Many years of eminently satisfactory operation and development have resulted in the collection of facts and figures—which in most cases are favorable enough to impress the most wary skeptic as to the potential in well-planned automatic operations.

Consider the value of CTC to the railroad industries: Records indicate that the operating capacity of a single track is increased by 50 to over 100 per cent; operating costs are reduced by saving tonnage freight trains an average of over a minute a mile; and a study of 26 CTC installations prepared by the Economics Committee of the Signal Section, Association of American Railroads, indicated that a savings per year of $2,140,355 was realized on an expenditure of $7,818, 595—a yearly saving of 27.4 per cent of total investment.

From the engineering and manufacturing viewpoints, knowledge of early forms of successful automation in other fields is important because these early forms represent proved experience in methods and techniques—established points which can serve as guideposts to all other industries interested in progress. This is merely a restatement of the principle that automation is horizontal in nature. Details may differ, but the fundamentals of the elements of automation—such as suitable means of controlling complex operations—apply to all industries.

▶ Need For Traffic Control

With CTC, one man sitting at a desk console follows the course of all trains through a given area and directs their movement through a multiplicity of remote controlled signals and switches. This is considerably more than a minor improvement of the more usual methods of traffic control involving manual signals, telephone connected control points, written movement orders, time schedules, superiority of trains, etc. As in any traffic control situation, the major problem involves the conflicting requirements of a number of units which operate over a given traffic circuit—requirements which must be satisfied within the limits imposed by safety. In railway transportation the problem is compounded because of the particular limitation to the maneuverability of the involved trains and the general limitations as to how much

money can be intelligently spent to supply additional track just to introduce increased flexibility in the use of existing tracks.

In more detail, the particular traffic control problem of the railroad industry involves a combination of the conflicting needs of scheduled trains advancing from opposite directions (meets), scheduled trains with different speeds advancing from the same direction (passes), and the sporadic use of the same track circuits by special trains, such as switch units.

Briefly, one type of CTC installation as conceived by Union Switch & Signal, Div. of Westinghouse Air Brake Co., as a solution to these problems, is an all-relay control system designed on the time-element principle. The major elements of the system are:

1. Central control point which houses a control machine equipped with various levers to initiate the remote operation of track switches and wayside signals; indication lights on a control panel which reflect the condition of switches and signals and also the occupied or unoccupied condition of sections of track as represented on a track model; an automatic train graph which makes a permanent record of train movements or other information; and the necessary equipment such as relays, etc., to effect the above, *Fig.* 1.

2. Equipment at each controlled location consisting of power switch machines, signals, relays, power source, etc. This equipment not only receives and executes instructions from the main control point, but also transmits back to the central control machine evidence that the instructions have been carried out. The field equipment also transmits signals reflecting the passage of all trains, *Fig.* 2.

3. One pair of control wires, extending from the central control machine, to which are connected all controlled locations.

TYPICAL ALLOCATION OF CONSECUTIVE CODE STEPS

IMPULSE	CONTROL CODE	IMPULSE	INDICATION CODE
1 long	Line check and lockout.	1 short	Line check and lockout.
2 to 8	Each station code combination has three long and four short impulses. Thirty-five stations possible.	2 to 8	Same as control code.
		9 long	Switch is normal.
		10 short	Track is clear.
		10 long	Track is occupied.
9 long	Normal switch.	11 long	Switch is reversed.
10 short	(Special control if impulse is made long).	12 short	Approach is clear.
		12 long	Approach is occupied.
11 long	Reverse switch.		
12 short	(Special control if impulse is made long).	13 long	Left signal is clear.
		14 short	Power is on.
13 long	Clear left signal.	14 long	Power is off.
14 long	Clear call-on signal.	15 long	Right signal is clear.
		9 & 11 short	Switch is open.
15 long	Clear right signal.		
13 & 15 short	Signals to stop.	13 & 15 short	Signals at stop.
14 short	Call-on signal to stop.	13 & 15 long	Time release operating.
16 long	Reset code apparatus to normal condition.	16 long	Indication stick relays operated on selected panel. Code apparatus reset to normal condition.

Fig. 3—Control codes originating at control machine and indication codes originating at the field location always consist of 16 impulses. Duration of impulse occurring at a given count distinguishes the action which occurs as a result of the code.

Code System

Transmission of intelligence over this particular system is by a code which consists of a series of 16 impulses, any of which may be short or long. Individual transmissions of information, either from the control machine or the controlled point, always utilize the entire 16 impulses. Each impulse is given individual character by its position in the code and by its pulse duration. As can be seen from *Fig.* 3, two of the 16 impulses (1 and 16) are reserved for the operation of the code system; seven impulses (2 to 8) are used for station identification; and seven impulses (9 to 15) are used for function control and indication.

Each station to be controlled is identified by a three-digit number. Therefore, with the particular seven numbers allocated to station identification, 35 controlled points can be established for a given 16-impulse series. And each of the 35 controlled points, connected by a single pair of wires, is capable of controlling seven, two-position functions and also indicating seven, two-position functions. Duplicate use of the dc line circuit in carrying both control and indication signals is provided for by reversing the line polarity. When control codes are transmitted, the line is energized and de-energized with normal polarity, creating impulses which are followed by all 35 field stations through the receipt of the station identification code which isolates the exact controlled point. When any indication code is transmitted from a controlled point, the line polarity is reversed so that only the line relays at the central control machine and transmitting field station follow the impulses. Possible conflicts in transmission are provided for by the relay circuit design such that transmissions from the central office always take precedence, and transmissions from the field follow a station preference sequence.

Can Include Electronic Devices

This standard two-wire dc system can be extended to other sections beyond the limitations of 35 stations, without the need of stringing additional wire back to the control machine, by utilizing individual carrier frequencies superimposed on the single pair of wires to transmit signals from the central control point, *Fig.* 4. With suitable filters

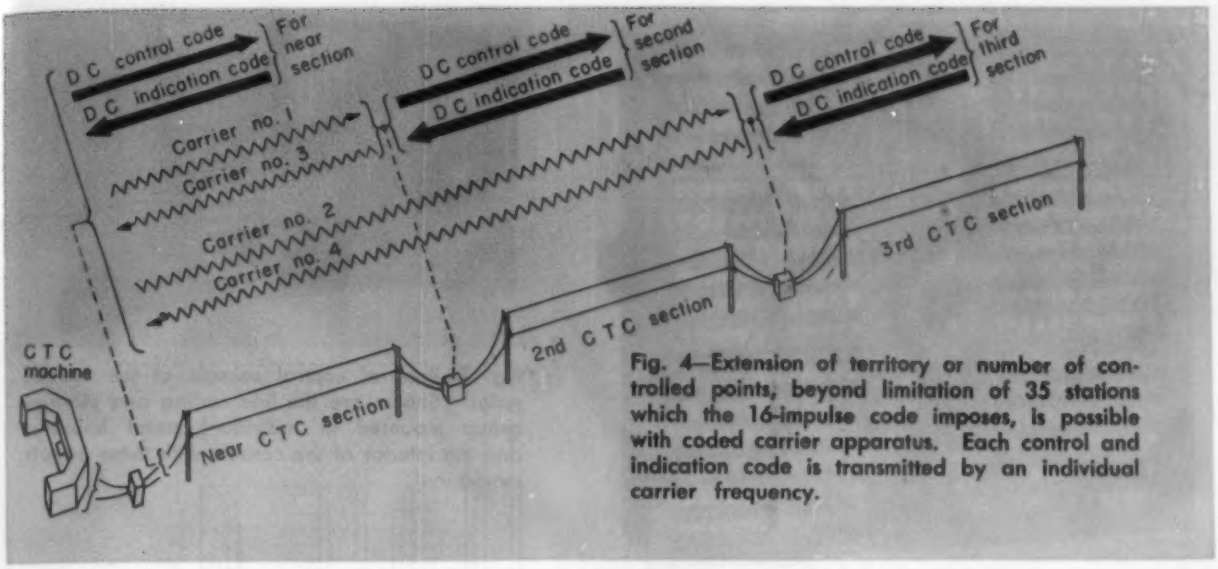


Fig. 4—Extension of territory or number of controlled points, beyond limitation of 35 stations which the 16-impulse code imposes, is possible with coded carrier apparatus. Each control and indication code is transmitted by an individual carrier frequency.

on the wire circuit and special receiving equipment designed to respond to a given frequency at a particular control section, the number of additional 35-station sections which are controlled over the same two-wire system is practically unlimited, being determined by the amount of operating territory that is desirable to consolidate at one control point. Each 35-station section is provided with its own line battery and the actual operation and response to the 16-impulse code is the same within each section. In addition to a special frequency for control codes originating at the control console, the indication codes originating in each field section are converted to coded impulses of a special frequency for transmittal back to the central control point. The office equipment converts these signals to dc impulses which in turn operate the office relay equipment.

The carrier equipment contains electronic elements and is subject to the normal frailties associ-

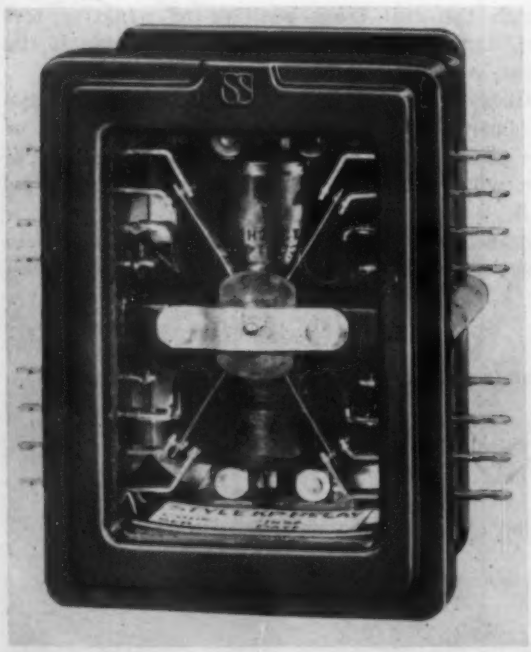


Fig. 5—Example of polar type relay used in CTC system. Relays are individually plug-connected for ease of replacement.

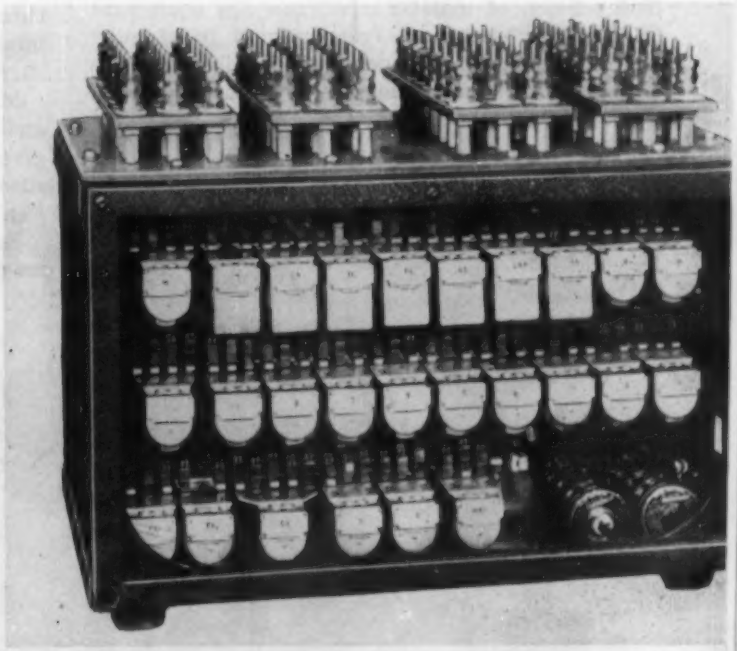
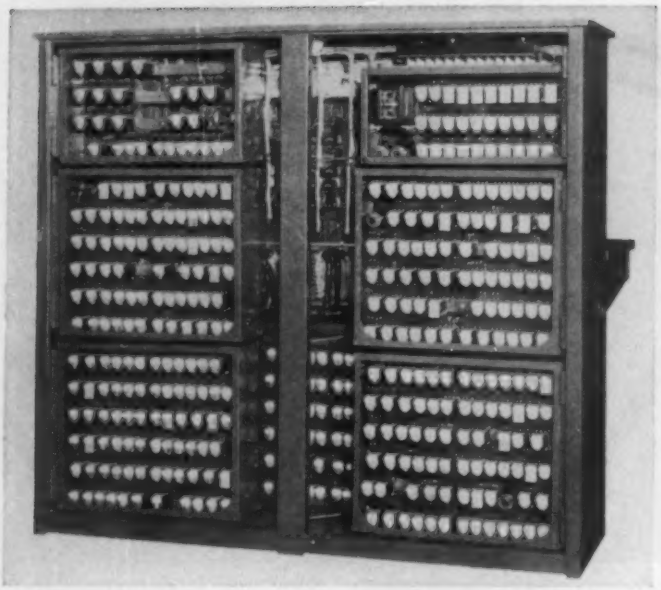


Fig. 6—Example of neutral relays used in CTC system. Both square and round armature type are represented. Connections for this particular unit are through plug connectors which engage sockets on top of the housing containing relays associated with a given operation.



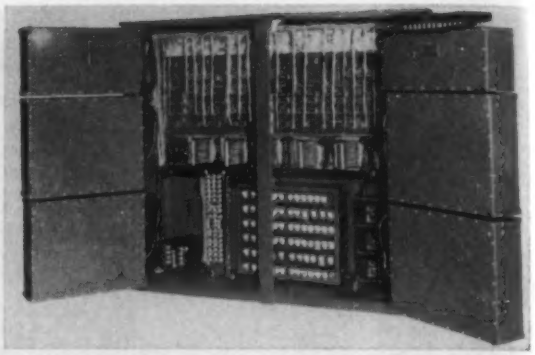


Fig. 7—Rear of control console at the central point. Shown are the line coding and storage group mounted in individual metal housings and the interior of the console with these panels swung out.

ated with such elements. The usual practice is to install duplicate sets of carrier equipment in the office and at each field carrier location. In anticipation of its use under abnormal conditions, this auxiliary equipment is adjusted to deliver a higher voltage and respond to a lower voltage than normal units. The philosophy behind using duplicate standby equipment is based on the importance of continued service of a given section which consists of a sizable number of control points. If spare equipment is needed, it is most logical that it is wired in place ready for use. As a consequence, it is not as important that the normal first echelon of maintenance know the equipment in detail. Changeover from normal to standby carrier equipment is under the control of the operator at the central console or is accomplished automatically in the event of certain line faults in the carrier circuit.

Basic Relay System

Two types of polarized relays and two types of neutral relays are used in the basic dc system.

BIASED POLAR TYPE: An example would be the line relay used in field locations to repeat line impulses transmitted from office, but not impulses transmitted from other field locations. These relays close one set of contacts when energy flows through the coil from positive to negative terminal, and operate in the reverse direction if the current is interrupted or reversed.

MAGNETIC STICK POLAR TYPE: Indication relays and control relays which respond to impulses of given polarity and remain in the last operated position without energy are examples of this type, *Fig.* 5.

SQUARE ARMATURE TYPE: The more complete magnetic circuit of a square type armature is used

Fig. 8—Interior of relay house at typical field location. All relays are designed for quick replacement. Special mounting of some relays on springs overcomes the problem of vibration associated with train movement.

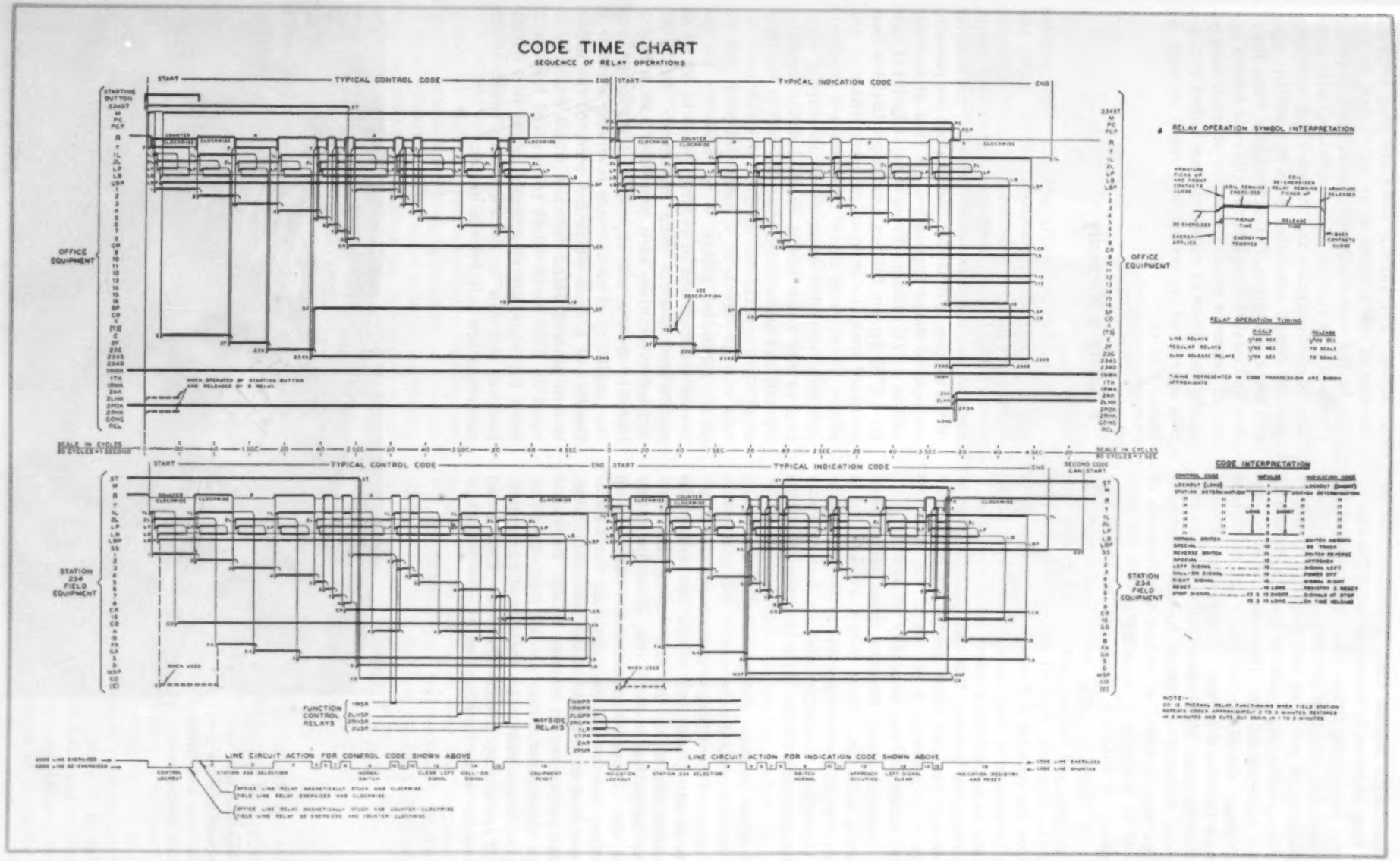


Fig. 9—Time and sequence of relay operations at office and typical field station. Illustration is based on code originating at control console calling on field station 234 to accomplish certain actions and field station 234 indicating that actions have been completed.

to obtain longer release time to produce, for example, long impulses in transmission of the code.

ROUND ARMATURE TYPE: The remainder of the relays used fall into this category, *Fig.* 6.

Limitations of space do not permit a thorough description of the relay circuits used in combining the four types of relays. However, as a general description, at the office, the relays can be divided into three functional groups: Line coding, pyramid and office storage. More specifically, the line coding group includes all relays directly associated with the line circuits; all relays the function of which is to generate a stepping action for code progression of outgoing codes and to follow this action for incoming codes; all relays involved in line checking and locking action and in the timing of the impulses; and all relays that interpret and store the code for delivery to the storage units at the conclusion of each code action. This group is housed in an individual sheet-metal case, *Fig.* 7. All connections between this unit and the line or between this unit and other groups are established through a plug connector on top of the unit, and thus the entire unit can be readily replaced.

The pyramid group includes those relays used for station selection. These relays are mounted in a single case and are connected to all other equipment through a connector block to facilitate any changes which may take place in station arrangements.

The office storage group includes the relays which initiate control code action; indication stick relays operated by indication codes received through the line coding group; and relays that deliver the information stored in the line coding unit during the indication code to the final indication stick relays. Those relays associated with a group of stations are housed in individual sheet-metal cases mounted on the rear of the control machine. As these units vary in makeup to suit individual location requirements, they are not plug connected.

Field code equipment also consists of line coding, pyramid and storage groups of relays. Each group performs the same functions as its counterpart in the office. The various units are plug connected for ease of replacement as an entire unit. In addition to the code equipment, each field station is equipped with various relays associated with actual control of the signals and switches and various indication relays associated with the switch, signal and track conditions, *Fig.* 8. Basically, then, the relays and related equipment in the code system consist of means of supplying either short or long impulses and means of counting these pulses with certain operations occurring as a result of each impulse, *Fig.* 9.

Safety a Necessity

Such a thing as centralized control of railroad traffic would not be possible if proper safety features could not be provided. In other industries which utilize large quantities of switching relays, such as the communication industry, malfunction of the system is cause for concern but the potential seriousness never approaches the case of malfunction in a CTC system. From the standpoint of safety, a CTC system follows a principle that has been standard with the railroad industry wherever possible. All wayside signal functions are dependent primarily upon the occupied or unoccupied condition of the track and a check between opposing signals, and secondarily, upon the will of the operator. Through the use of circuits which interconnect various signals at a controlled point and adjacent controlled points, it is impossible for improper manipulation of control levers to set up an unsafe condition for train movement. As an additional precaution, each controlled switch is protected by detector and approach locking to eliminate the possibility of an operator reversing a switch in the face of a train which has accepted the indication to proceed. Hand switches, which might be located on CTC track where train speed exceeds 20 miles per hour, are electrically locked in a normal position and can be unlocked only when traffic conditions are safe for the unlock.

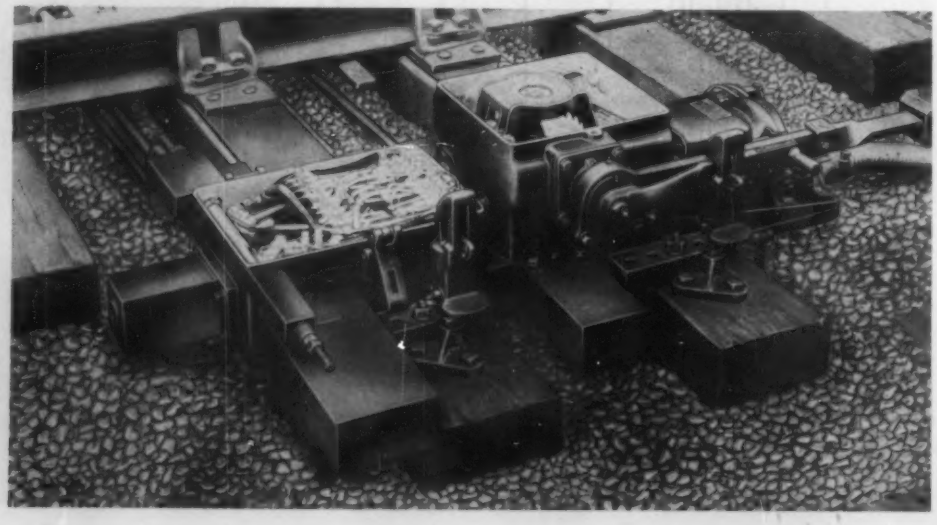


Fig. 10—Typical electric switch machine with covers removed to show motor, gear box and circuit controller compartment.

Fig. 11—Recent advancement in control art in railroad industry is represented by freightyard automatic classification installation. As part of operation, retarders automatically slow down moving freight car to ideal coupling speed depending upon weight of freight car and distance which it must travel. Lever manipulation sets up route each car is to take or this information can be fed to machine by punched tape.

Logically, maximum safety is achieved in the overall sense by designing independent safety features into each type of equipment which goes to make up the total system. As an example, the switch machines, either electric or electropneumatic powered devices, *Fig.* 10, are equipped with a lock rod arrangement which serves as a mechanical lock insuring that a switch cannot be moved unless the controlled pneumatic or motor power drive linkage also is actuated through a normal cycle. Each switch also contains an electrical position indication circuit that is dependent upon the joint action of the switch mechanism and the proper movement of the actual switch points as checked by a separate point detector mechanism. In anticipation of circumstances where switch points could be deflected by train traffic, such that the actual point conditions would create an unsafe situation though the detector bar indicated otherwise, mechanical means have been included in each switch to hold indication points open once a considerable displacement of the detector bar of a locked switch has occurred because of unusual traffic conditions. Subsequent operation of the switch will reset the latch if no damage has been done. If damage has resulted from the traffic, the actuating mechanism is fouled by the latch and maintenance need is indicated by the inability of the switch to signal a locked condition.

A Basis For Further Progress

These general observations illustrate the advanced level of development in only one segment of the field of control within the railroad industry. The significant fact is that advancement in this particular case has been successfully built around components whose capabilities are not often sufficiently appreciated or understood.

If appreciation of the full capabilities inherent in combining electrical, electronic, hydraulic, pneumatic and mechanical elements is so important to obtaining the best automation system, one might expect to find outstanding examples developed by a company with considerable experience in integrating these elements into a system; and also a widening area of interest of that company in view of the expanded need for equipment utilizing these elements. Such is the case with Union Switch & Signal. Recently announced developments by the company include an automatic control system designed for freight car classification yards which includes a central computer type device capable of receiving data from punched tape and automatically integrating this data with such factors as car weight and speed, track conditions, etc., to control the movement and speed of free-moving freight cars in achieving ideal coupling conditions, *Fig.* 11. Other recent announcements indicate the entry of this company into the field of remote control of pipe lines and stations.

In Summary

Control equipment used in the railroad industry exemplifies the results which can be attained by the realization and confidence that sound engineering and manufacturing practices can provide the means for solving difficult industrial problems involving the need for minimum maintenance, extremes in operating conditions and foolproof operations. The concepts of sound engineering and manufacturing practice embrace more than theoretical technical competence. Theoretics must be balanced by practicality—the type of practicality that is a summation of experience across many industrial fields and not just conventions as practiced within one industry.

1

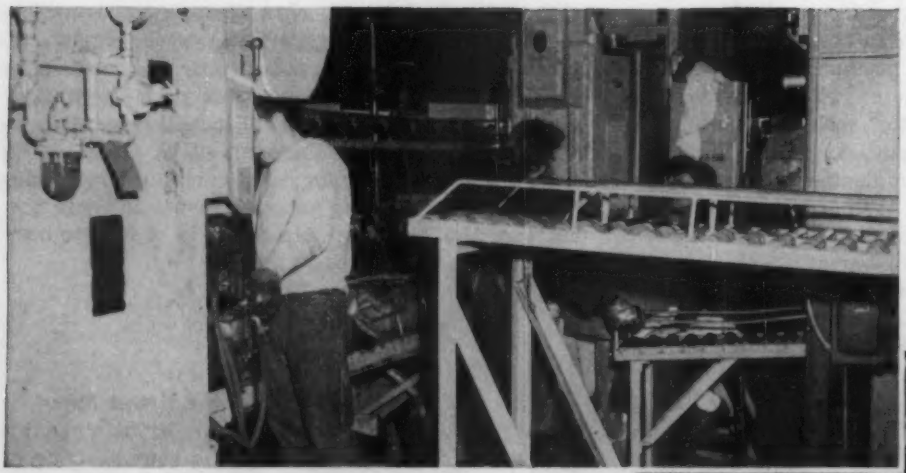
Ammunition carrying boxes are fabricated of 0.047-inch thick mild steel (SAE 1047). Rubber gaskets in the covers of the boxes make them water and air-tight after the welders have joined the box seams.

Bottom of the box is seam welded on a dual-head, dial fed, 200 kva special seam welding machine that was designed and built by the Taylor-Winfield Corp.

2

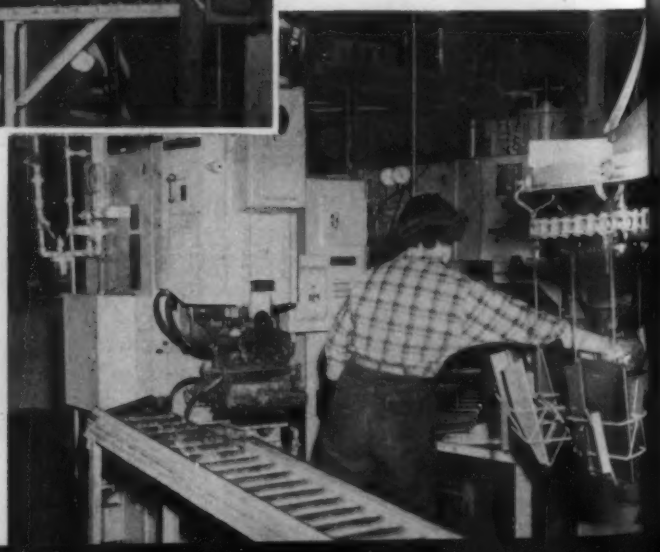
AUTOMATION TODAY

WELDING AMMUNITION BOXES



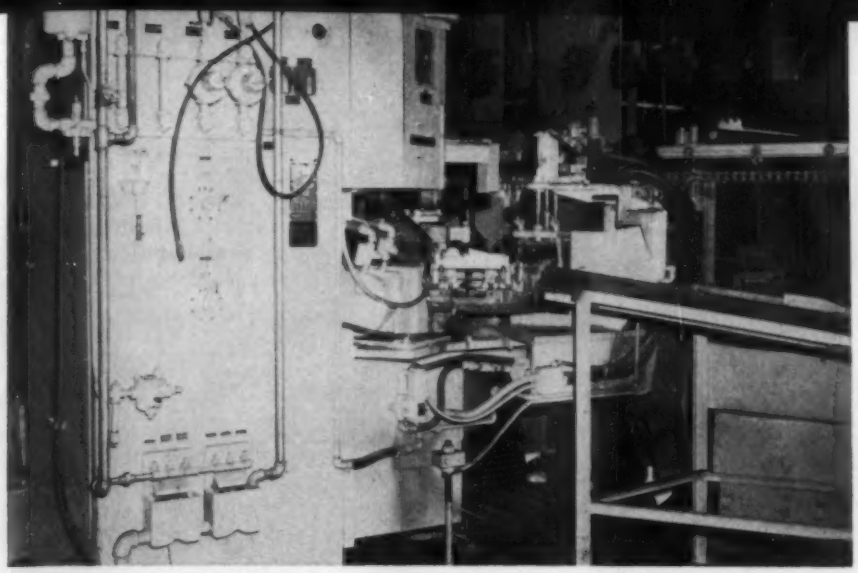
3

No bolts or rivets are used in the construction of these boxes. At this position on the line the front latch and rear hinge are secured to the box by two projection welders.



4

Material handling is accomplished by conveyors that feed assembly stations on the line. Operator hand loads box covers to this machine that projection welds rubber gasket retainer into box cover. Finished work is transported away by conveyor.



5

Special projection welder for fastening two handle clips and the hinge and lock clips to the box cover. Machine is equipped with dial-feed table that moves workpiece into welding position.

PRODUCING military supplies is a highly competitive business, for the contracts go to the source that can meet the specifications of the product at the lowest selling price. It is natural that producers of these goods turn to automated production methods in order to keep costs of large quantity production at level that will permit them to maintain the competitive advantage.

The existence of such facilities is in the national interest to the extent that in the event of a military emergency production quantities can be more quickly increased.

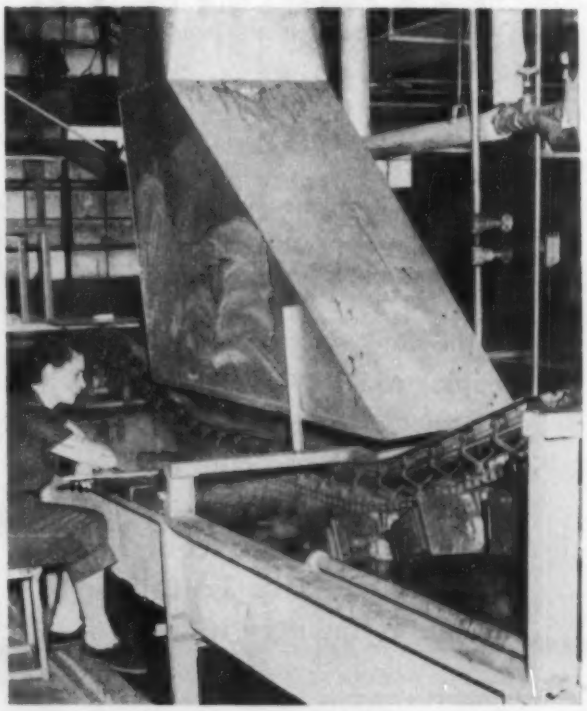
Typical of the advanced thinking that has gone into this type of production is the assembly and finishing of ammunition carrier boxes at the Metal Carrier Corp. In a line that was set up to produce in excess of 500 boxes per hour, the components are welded, painted, and tested as described by the accompanying photos.

Specifications call for the boxes to be fabricated from 0.047-inch thick mild sheet steel (SAE 1047). All hardware, hinges, handles, and locks are projection welded to the seam welded box or its cover. Taylor-Winfield Corp. has supplied standard and special welding machines to handle the required production. Rubber gaskets in the covers of the boxes make them water and air tight.

This high production installation uses trolley and roller conveyors to transport the parts to and from the work stations of the line.

6

Operator loads conveyor that takes boxes and box covers through bonderizer and paint tanks.



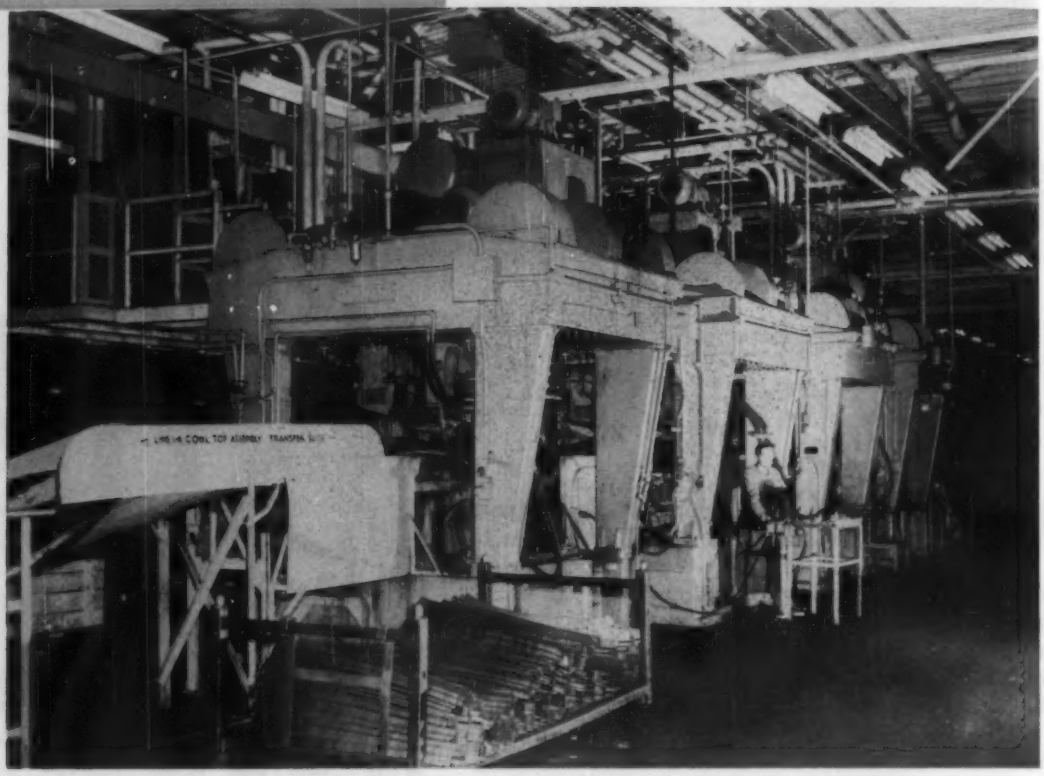
7

Final inspection station where completed boxes are checked. Metal Carrier Corp.'s production techniques turn out less than 0.5 per cent reject assemblies.

POWER FOR AUTOMATION WITH DC DRIVES

Part 1

Fig. 1—Automation conveyor powered by Reliance VS drive carries work between blanking, drawing, and welding operations at the Ford Buffalo stamping plant in response to switching signals given by completion of each operation.



ELEMENTS OF SPEED CONTROL

By V. R. MURPHY
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As the field of automation grows, people working with it need to have at their fingertips a broad selection of the tools of automation. Here is a three-part discussion of an important set of these tools—motor drive systems applicable to industry wide needs.

THE NEED for controlled power crosses all industrial lines. Many examples illustrate the universal place of sensitive, responsive motor drives in the automation picture. A substantial portion of the processes and systems subjected to the techniques of automation requires motor driving power that reaches significant horsepower levels—in the order of ½ to 500 horsepower. This power must respond with delicacy and precision to the low level signals available from controlling devices. This article concerns itself with a general description of electric drives and their elements for these automation systems. We shall begin by briefly describing a few of these systems which point up various requirements filled by dc drives.

In automotive manufacturing, conveyor tables powered by specially designed and built Reliance variable speed drives carry work between blank-

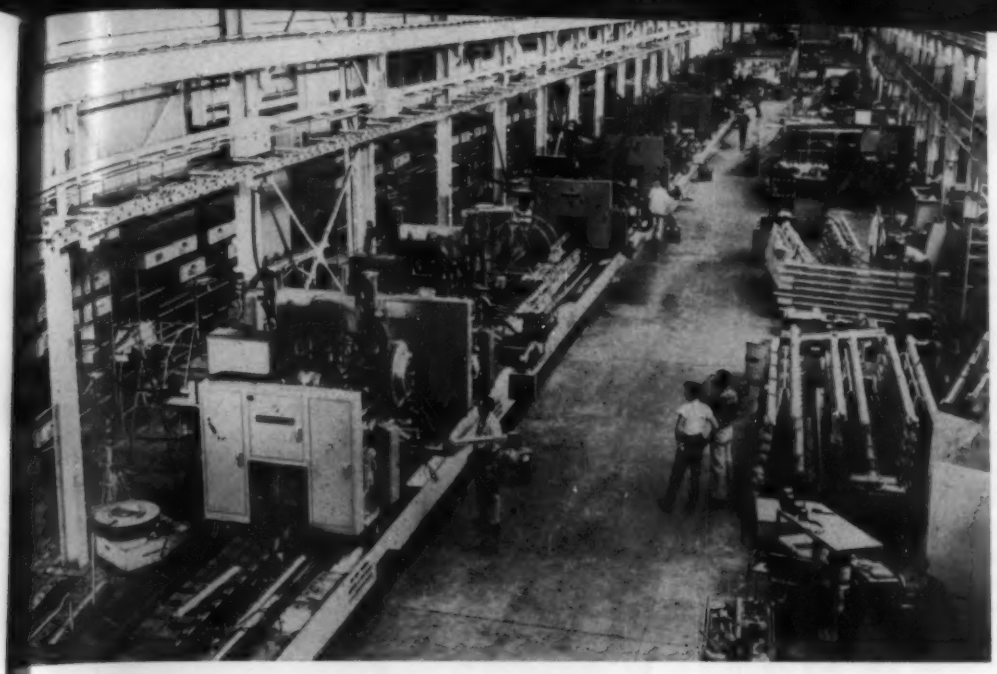

Fig. 2—Farnham milling machine produces aircraft spars. Reliance VS drives move the tools along the work at speeds that keep maximum load on ac cutting-tool motors.

ing and drawing presses and between welding operations in response to switching signals from the presses which indicate completion of the previous operation, *Fig.* 1. The principal requirement that dictates the nature of this drive system calls for extremely rapid acceleration and deceleration —the point of final stop to be accurate within a few degrees of motor shaft rotation. Acceleration and deceleration times of 0.3 to 0.5-second are involved.

Mining of low grade iron ore (Taconite) has brought new specifications to conveyor drive performance in the ore processing stages. The processing is controlled in part by the rate of entry of ore into the system. Leveling conveyors measure weight and rate of conveyor flow and signal the variable speed drive to maintain a constant ton per hour rate of flow. When jamming overloads occur, the driving motor must stop or run very slowly until the jam is cleared, then return automatically to set-speed as conditions return to normal.

As an example from the machine tool field, milling machines are used to machine long spars used in aircraft manufacture, *Fig.* 2. The rotary cutting tools are driven by ac motors; the tools and housing which supports them are driven along the work by variable speed drive. For maximum production efficiency it was recognized by the machinery builder that the cutter-driving motors should be kept fully loaded. This has been accomplished by feeding continuous load measurements from the ac motors into a regulator which causes the motor that is drawing maximum load to determine the speed of the feed-drive motor. If this load increases, the feed drive slows down to hold the set-value of ac motor load. If the cutter motor drawing maximum load becomes

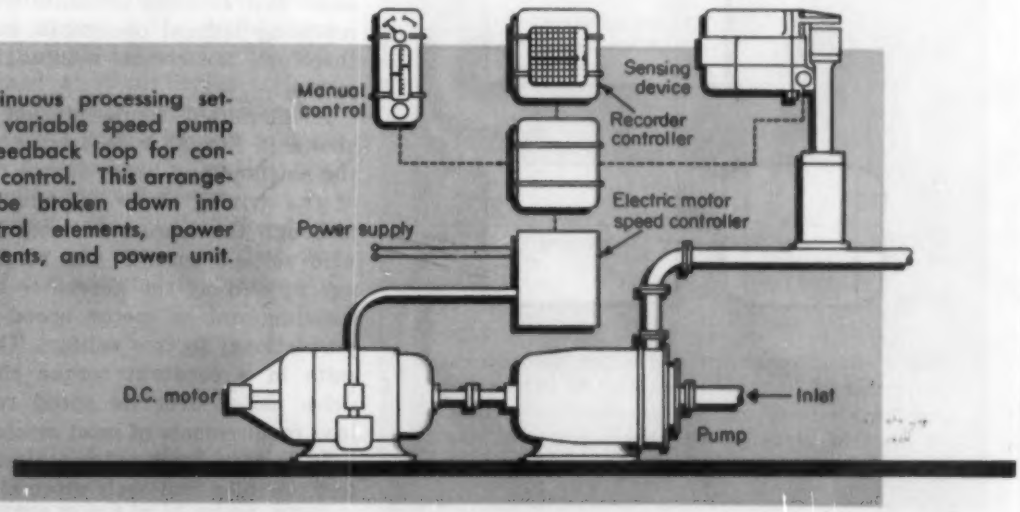

Fig. 3—Continuous processing setup using a variable speed pump drive in a feedback loop for continuous flow control. This arrangement may be broken down into system control elements, power control elements, and power unit.

more lightly loaded than another, the other motor takes over the feed control.

In the manufacture of certain plastic films, it is necessary at one stage to maintain close control of pressure (affected by buildup of cake on a filter) by a pump. Traditional ways of solving the problem were complicated by the limitation that material could not be bypassed without a severe effect on quality. The answer has been a variable speed pump drive whose speed is regulated by a controller operating from a pressure signal at the point of desired control, *Fig.* 3. Maintaining a narrow differential gap was a paramount consideration which resulted in selection of a high-gain amplifying exciter to transmit the controller signal through to the drive motor. Such an exciter provides not casual obedience to signal, but forced rapid response which drives the system back to the set-point as soon as an error appears.

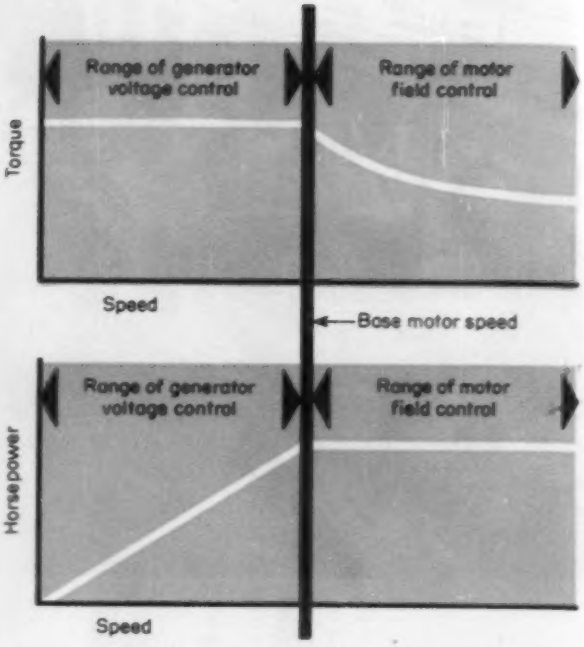

Fig. 5—Torque and horsepower characteristics of a simple variable speed drive system. Speed control below base is provided by adjusting the voltage applied to the motor armature. Speed control above base is provided by adjusting motor field current.

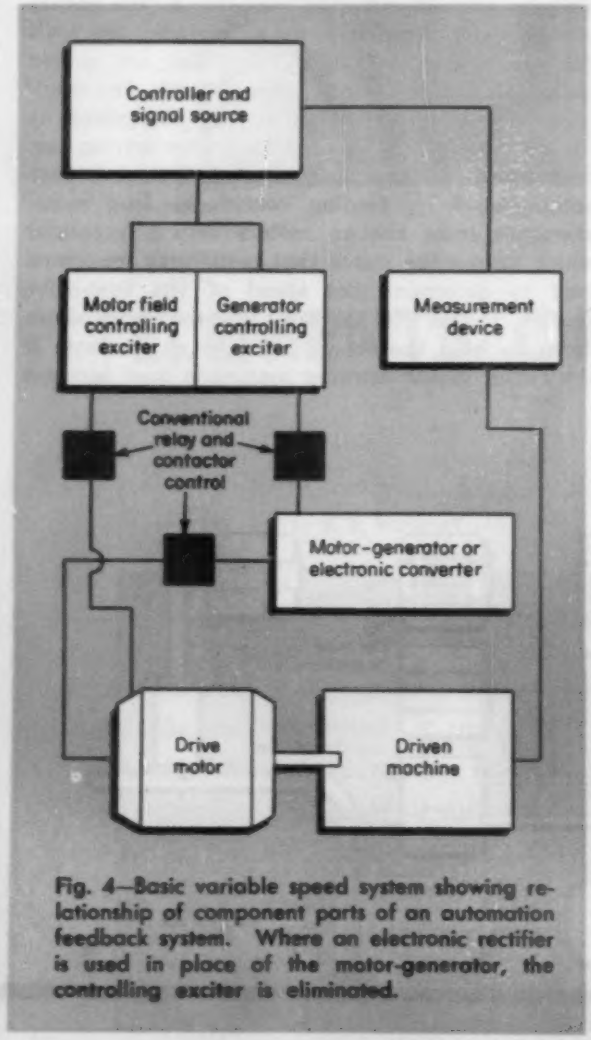

Fig. 4—Basic variable speed system showing relationship of component parts of an automation feedback system. Where an electronic rectifier is used in place of the motor-generator, the controlling exciter is eliminated.

Basic System Elements

In the most basic thinking, any method of supplying power to a machine can be broken into system intelligence or control signal, power control and power. Conventional methods with which we are all familiar employ an operator as the master control; contactors, relays, valves, rheostats, etc., as the power control; and motors or cylinders as power devices. We will take a close look at these elements with the intention of replacing manual operations at least in part, and therefore, somewhat rearranging the other elements.

A simplified representation of the system is shown in *Fig.* 4. A dc driving motor is coupled to the machine and is the source of power. The speed of the driving motor is controllable in two ways although the answer to most problems is adjustable voltage control; the magnitude of the voltage applied by the generator to the motor armature determines motor speed, which is roughly proportional to this voltage. This arrangement results in a constant torque characteristic of the drive motor over its speed range to match the load requirements of most machines.

In certain types of machines, notably machine tool spindles and web processing winders, a con-

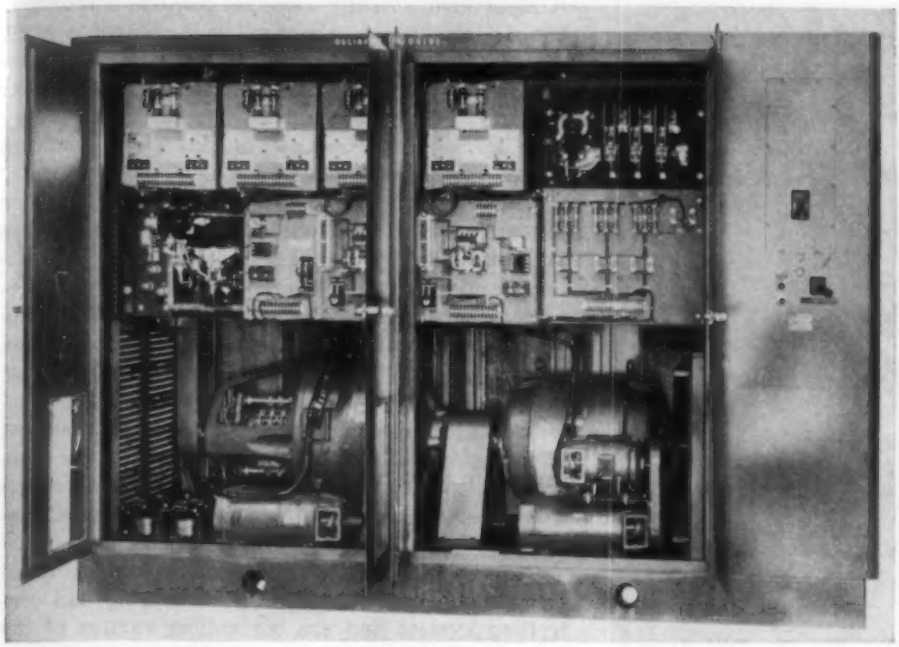

Fig. 6—Packaged variable speed motor drive system. These systems are used to control tension, acceleration and deceleration and to regulate and synchronize speed.

stant horsepower range is required, either in addition to or in place of the constant torque range. For these relatively special situations, a controlling exciter supplies excitation to the motor field. It takes over after the generator has reached maximum voltage and extends the speed range upward by reducing motor field current in response to signal. This higher portion of the speed range has a constant horsepower characteristic or, conversely, a decreasing torque characteristic with increasing speed, *Fig.* 5.

In the adjustable voltage portion of the speed range, the dc motor armature voltage can be supplied by a properly controlled electronic rectifier as well as by a generator. The choice of rotating versus electronic conversion is a matter of economics. Situations must be studied individually before an intelligent choice can be made.

The method of motor speed control just described (the motor-generator set and motor) is old and well known in its basic form as the Ward-Leonard system. What is new is the performance that can be attained through engineering the system as an entity aimed at a particular task or class of tasks. From controlling exciters to motor-generator set and motors, a better job can be done when each element is designed with the intention of using it in a particular kind of system.

We can generalize now and say that the drive motor and generator or electronic rectifier are conventional parts of the systems in function if not in design. The controlling exciters or the input circuits to electronic rectifiers are the items to which we should devote some attention. They are go-between devices—they must operate with input from a limitless variety of signal sources and must supply controlling currents to a wide range of generator and motor sizes and types. Through years of experience, controlling exciters—mostly electronic in construction—have been made reliable from a quality and maintenance standpoint and have the adjustments and characteristics necessary for proper functioning with the

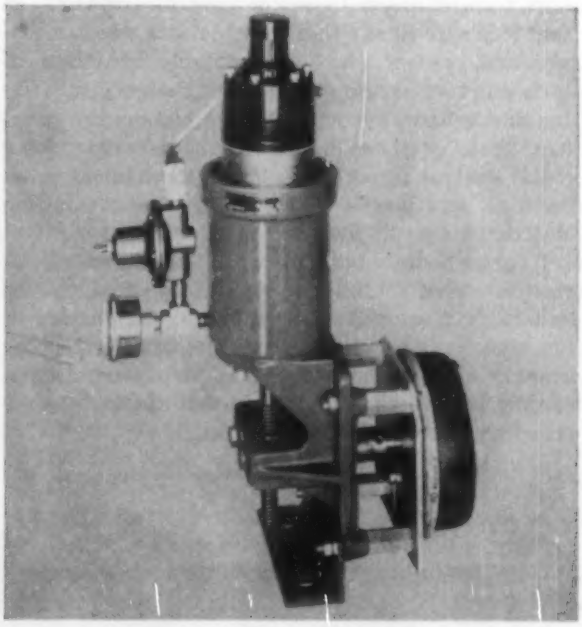

Fig. 7—Conoflow controller, for systems where air pressure is the controlling medium, operates a rheostat or potentiometer in response to a 3 to 15 psi air signal.

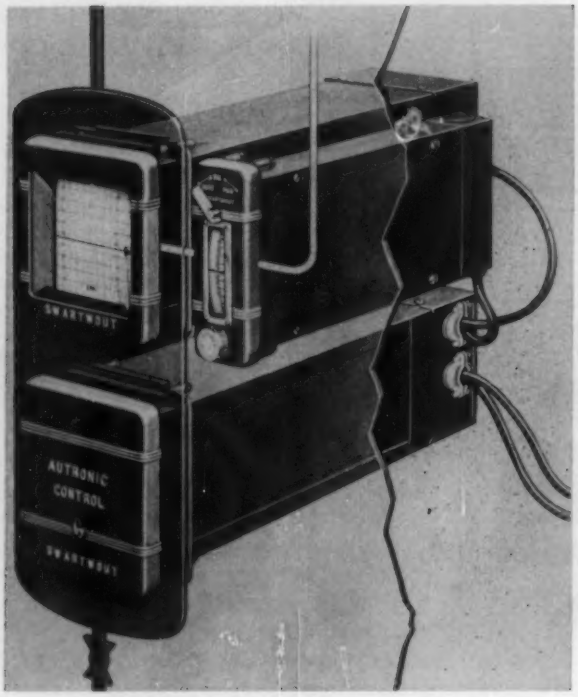

Fig. 8—Swartwout recorder-controller provides a dc output signal to operate directly into a Reliance VSR regulator.

range and kinds of rotating equipment with which they are used. It is generally true that development of controlling exciters has been wedded to the development of the power drive systems, *Fig.* 6.

▶ Signals for Automatic Control

In contrast, items of the controller and signal source category have arisen as a result of many different needs and with different degrees of intent toward use with motor control systems. In fact it is safe to say that most devices which measure and control (with the notable exception of tachometer-generators) were not designed initially for motor drive systems. It has become the problem, then, of those interested in extending automatic control into the realm of mechanical processes to find means of signalling and controlling electric systems.

A good many methods exist for signalling an electric drive. While it is not practical to list and explain completely the determining factors in the choice of signal and drive combinations, a reasonably clear picture of the major considerations can be made. Signalling systems can be divided into three convenient categories:

1. Rheostat operation or adjustable resistance control.

2. Other transducer operation.

3. Voltage adjustment or adjustable voltage generation.

A rheostat is actually a special purpose transducer, but its importance in motor speed control is great enough to warrant individual attention. Transducers may take any form that meets the definition of transforming mechanical into electrical energy such as a reactor whose inductance is changed by the motion of a plunger rod.

Whenever an electronic or magnetic amplifier controlling exciter is used, the system is suitable for operation by voltage adjustment since electrical signals of only a few volts and a few milliamperes are required as input to the exciter. As an illustration, if a drive is to be arranged to run at a speed proportional to the speed of another machine, it could be controlled through a tachometer-generator mounted on the controlling machine. Tachometer voltage would be fed into the controlling exciter, and the magnitude of this voltage would determine drive speed of the controlled machine.

Keeping in mind that the three categories listed provide the link between any measuring and controlling system and the controlling exciter of the drive, we might look at examples of controllers which fall into these categories.

1. Most standard recorder-controllers are suitable for actuation of an electronic relay whose contacts operate a motorized rheostat and thereby control drive speed.

2. In systems where air pressure is the controlling medium, at least two standard devices exist which will operate a rheostat in response to a 3 to 15 psi air signal. These are the Conoflow controller, *Fig.* 7, and the Foxboro controller.

3. At least one standard recorder-controller on the market, made by Swartwout Co., *Fig.* 8, produces a dc output signal of sufficient magnitude to operate directly into a Reliance VSR high gain electronic regulator (controlling exciter).

Where pneumatic or electric instrument control systems are involved, measuring devices located at the points of measurement feed signals to the con-

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His academic background includes a B.S. in electrical engineering and an M.S., both degrees granted by Massachusetts Institute of Technology. Mr. Murphy is a member of Tau Beta Pi and Eta Kappa Nu.

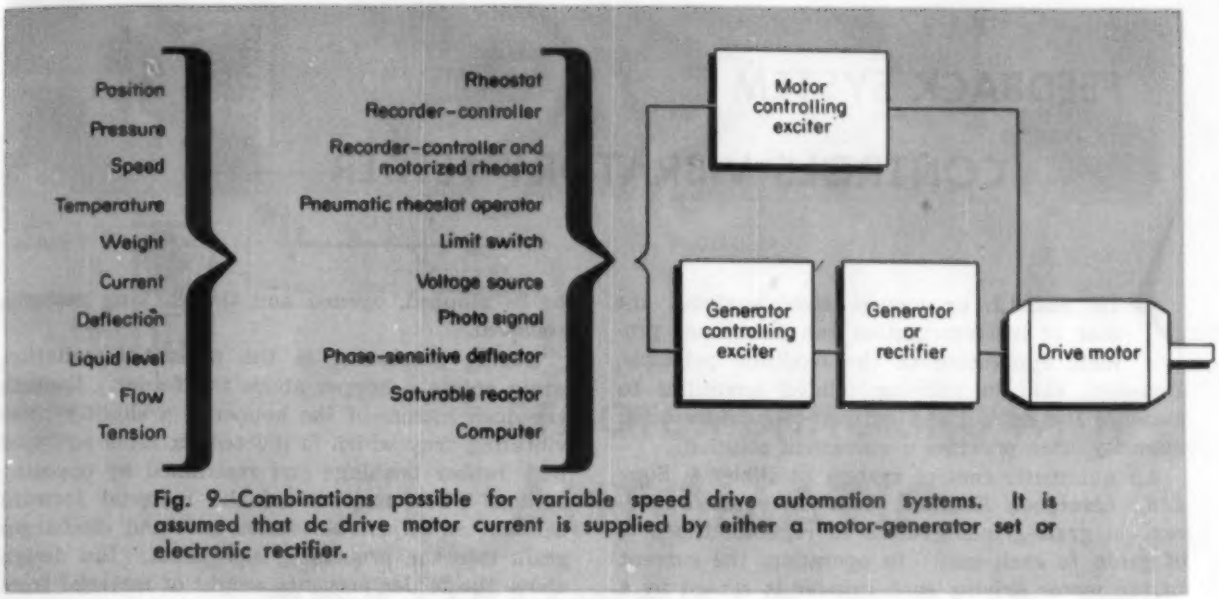

Fig. 9—Combinations possible for variable speed drive automation systems. It is assumed that dc drive motor current is supplied by either a motor-generator set or electronic rectifier.

trollers. These devices may be standardized for use with various controllers or they may be such that special electronic circuits can be developed to transmit their output to the controlling exciters. In any event, each system consists of a measurement of some kind fed into a regulator or controller which converts the signal into proper form for the controlling exciters, *Fig.* 9.

Beyond these instruments are a number of devices simpler in nature which can operate a variable speed drive. Limit switches traditionally are used in large numbers to start, stop, reverse, and switch speeds. Voltage signals generated by many means are used regularly. Tracer controls utilize phase sensitive deflection heads. Photoelectric cells control camber in the manufacture of sheet steel.

Use of computers in practical installations is limited to very special and unusual circumstances, but their possible future use makes mention desirable. It is enough to say that analog information can be used directly in conjunction with some of the elements we have been discussing here. Digital information can be converted to analog for these purposes, retaining its inherent high accuracy by proper systems design.

Ability of these process control devices to work into variable speed drive systems means that a great variety of control problems can be solved. If a process lends itself to measurement by instruments of the recorder-controller class and if power can be supplied by means of an electric motor, the process can be made automatic.

The second article of this series will discuss variable drive motor operating characteristics or what they will do.

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CONTROL UPGRADES PRESS OPERATIONS

ELECTRONIC control which attaches easily to stamping presses to reduce or eliminate the possibility of damage to dies and presses due to double heading on nonejected parts has been developed by Robotron Corp., Detroit. Use of the portable control also reduces the possibility of accidents, allows faster automatic feeds, permits one operator to control more than one press, and can be made to count only the parts stamped. The fail-safe control is enclosed in a small shock-mounted cabinet.

The operating principle is based on stamped ferrous or nonferrous metal parts passing a detection device at a time interval which has been set by a dial on the control panel. Passing the detection device causes an electrical impulse which energizes the control relay, and closes a set of normally open contacts for a predetermined period. The contacts will stay closed as long as these impulses are repeated within the interval set on the dial, indicating normal part ejection. When impulses repeat outside of this interval, the parts are not being ejected fast enough and the relay contacts will open, stopping the press.

The unit may be used for any stamping application where the press cycle can be made to stop at the top of its travel as it completes a revolution, or can be made to stop just before the punch enters the lower die. The press must be electrically initiated.

FEEDBACK SYSTEM CONTROLS VIBRATORY FEEDER

IN SMALL or modest sized systems, the cost of instrumentation can sometimes prohibit application of the feedback principle. However, skill in utilizing related quantities to measure the critical and difficult-to-measure basic quantity often provides a convenient solution.

An automatic control system at Bibby & Sons Ltd., Liverpool, England, uses drive motor current in grain-grinding units to regulate the flow of grain to each unit. In operation, the current to the motor driving each grinder is sensed by a current transformer which is connected to the control unit, *Fig.* 1. If the grinder motor current falls below full load, the controller regulates a small geared reversing motor on the vibrating feeder and the rate of feed to the grinder is increased. If the grinder motor current exceeds full load, the feed rate is gradually reduced. The controller is so arranged that a dead band covering plus or minus 2½ per cent of full load minimizes hunting.

Each grinder is fed by a vibrating feeder, known as the Velofeeder, which is especially suitable for use in automatic feed-control systems. This device is exceptionally efficient because a system in resonant vibration is utilized. Powered by a ⅛-horsepower motor, it can be regulated to produce a wide range of amplitudes, from as much as 3/16-inch to zero, making it possible to handle a wide variety of materials. The conveying rate at maximum amplitude is estimated to be about 70 f.p.m.

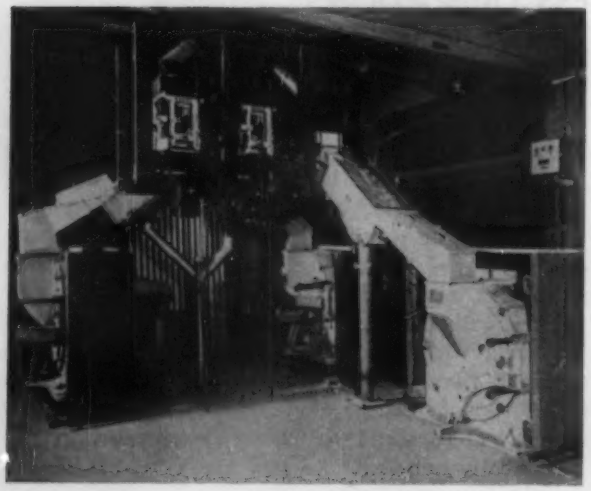
Before installing this automatic control system, overfeeding frequently choked the grinders at the Bibby mill. To right matters, the grinders had to be stopped, opened and the choking material removed.

During processing in the present installation, grain enters a hopper above the feeder. Beneath the open bottom of the hopper is a slightly tilted vibrating tray which is pivoted on arms equipped with rubber bushings and restrained by opposing springs. The tray moves the material forward beneath an adjustable outlet gate and discharges grain into the processing equipment. Bin design above the feeder prevents weight of material from resting on the vibrating tray.

In the vibrating cycle, the feed tray moves forward and when it reaches the limit of its travel, is suddenly returned by the impact of an anvil pad which is part of a separate spring system that is also vibrating in the direction of the feed. This spring system is energized by a small rotating eccentric weight.

Beside the "kicks" it receives from the anvil pad, the feed tray also receives impulses from springs mounted on a vibrating anvil attached to the tray. No matter how hard a kick it's receiving, the feed tray vibrates near resonance—hence the small power input. Severity of impact depends on the distance between the feed tray and the anvil pad. This distance is adjustable and controlled by a hand lever. When feed tray and anvil are closest together, the feed tray has its maximum stroke.

Velofeeders were originally developd by Henry Simon Ltd., Stockport, England. The patents on the machine were later licensed to Richardson Scale Co. of Clifton, N. J., which is now sole manufacturer of Velofeeders in this country.



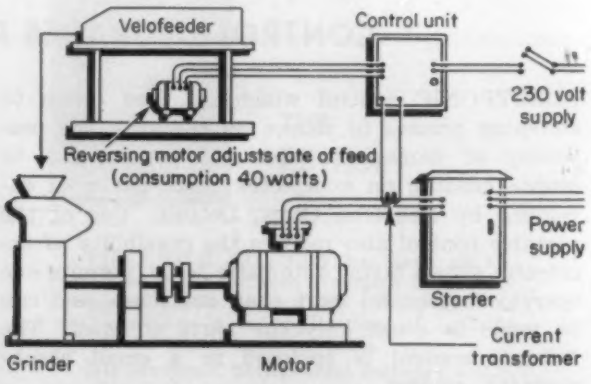
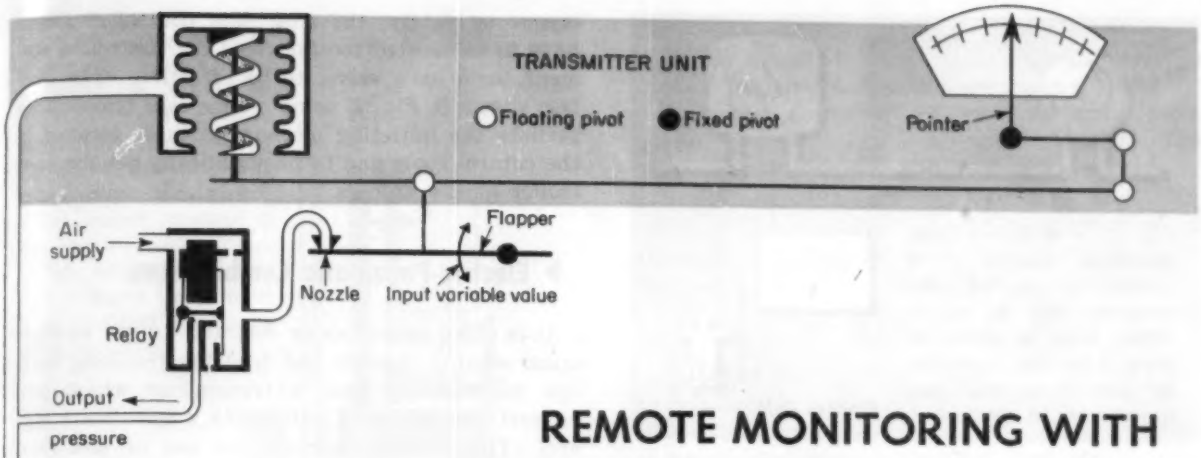


Fig. 1—Schematic sketch and photo of electronically controlled feeders for grain grinding machines. In this feed mill at Bibby & Sons Ltd., three grinders are now producing as much ground grain as did four previous to automatically controlled feeding.



REMOTE MONITORING WITH AUTOMATIC TRANSMITTING ELEMENTS

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Process information — temperature, pressure, flow, etc—not only must be accurate but also must be continuously available at specified locations if modern continuous processes are to be properly controlled. In many plants the specified location is some distance from the process sensing elements, and such layouts may require special sensing units or transmitters. Some devices and factors involved in such uses are noted in this article.

IN PROCESS INDUSTRIES, early control installations were predominantly on simple batch-type processes. The control instruments were mounted close to the process and were equipped with direct-connected sensing elements for temperature, pressure, flow, and other variables. With the trend to continuous and more complex operations, in which process equipment is widely dispersed, today's process engineers rely on centralized control rooms. And since the larger plants may cover many acres, remote transmission becomes essential from the standpoint of response time and economics. Transmitters themselves thus become important to such operations. As control components, they are vital to the control loop, linking the measuring elements to their associated receiver-controllers.

Because there are so many possibilities in the use of transmitters in control systems, available transmitter types and their specific advantages must be fully understood so that the most appropriate device can be specified for each individual application. The purpose of this article is to

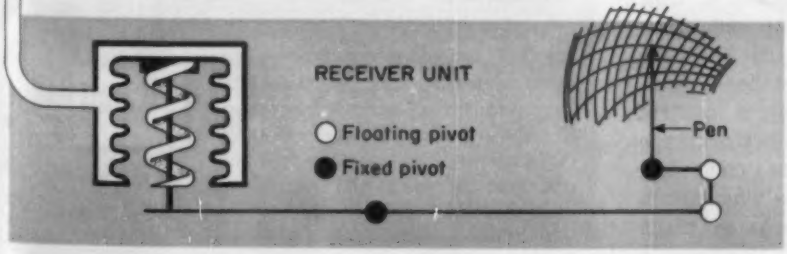

Fig. 1—Schematic diagram of a popular type pneumatic system. Variable values are indicated near the measuring element by the indicating transmitter and pneumatically transmitted to the remote receiver which may indicate, record or control the process.

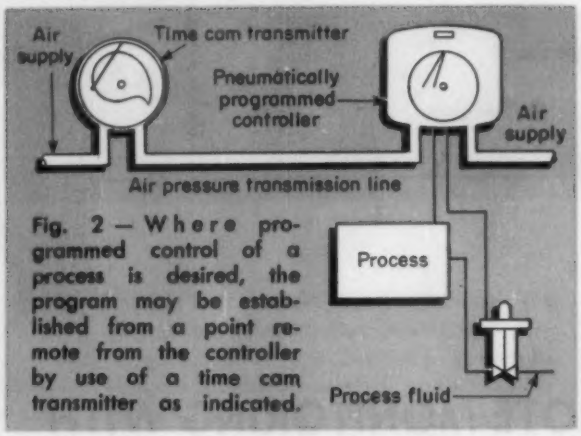

Fig. 2 — Where programmed control of a process is desired, the program may be established from a point remote from the controller by use of a time cam transmitter as indicated.

assist in building such understanding by discussing some of the transmitter types used in industry.

Pneumatic Units

A number of inherent advantages apply to the pneumatic type of transmitters. As a class, they are extremely reliable and can be counted upon to operate without maintenance for long periods providing the air supplied is clean and dry. Power failures—all too common in certain areas—need not immediately affect pneumatic instruments because air systems can be designed to have enough air under pressure to last for an appreciable period. Auxiliary standby air compressors can also be installed. In addition, air-operated devices are perfectly safe to use in chemical plants which have hazardous atmospheres. No expensive explosion-proofing is required with pneumatic types.

Characterized by wide range of application are pneumatic transmitters of the Foxboro Model 42 type, useful for a list of variables such as temperature, pressure, flow, liquid level, humidity, etc. A unit of this type is generally an indicating transmitter connected directly to the measuring element, *Fig.* 1, and converts measurements into an output air pressure which changes with precise uniformity in relation to changes of the measured variable. This air pressure, transmitted by tubing, is received by a standard indicator, recorder or controller usually located in the centralized control room. A pressure element in the receiver faithfully reproduces the original measurement.

Since a transmitter of this type is often mounted outdoors close to process equipment, all components are enclosed in a weatherproof case constructed of drawn steel. The case can be designed so that there is room in the case for alarms and other auxiliary mechanisms.

A variation of this type unit provides a convenient way of pneumatically setting a control point index according to a fixed performance schedule. Customarily, a time cam controller would be used, but there are instances where such a device is not practical. For reasons of plant layout or safety, the time cam controller might have to be located too far from the controlled element, such as a valve, to be effective. The system shown in *Fig.* 2, using a time cam transmitter permits the initiating mechanism to be located in the control room and to pneumatically set the controller at the process.

Electric-Pneumatic Combinations

It is often necessary or desirable to use an electrical sensing element and feed the resulting voltage measurement into a transmitter which will convert the electrical value into a pneumatic signal. This method permits the use of electrical sensing devices with conventional graphic panel pneumatic instruments so that the entire loop, with the exception of the initial measurement is pneumatic.

So versatile is this type of transmitter that it can be considered wherever there is a process to be measured or controlled. It will handle any electrical voltage measurement and, since any variable can be measured electrically (some, such as pH and oxidation-reduction potential can *only* be measured electrically) its scope of use is widespread. With the transducer-transmitter placed in close proximity to the controller, both the inherent speed of response of electrical measurement and the precise action of a pneumatic controller can be effectively utilized. In addition, the device permits a plant to standardize on a single type of recorder-controller responding to the 3 to 15 psi transmitter output, regardless of the type of sensing element that provides the initial measurement.

Typical of such transmitters is a recently announced emf-pneumatic transmitter, *Fig.* 3. This unit receives a millivolt signal from a measuring element (thermocouple, tachometer, etc.) converts it into a proportional 2000 cycles per second ac voltage, amplifies and filters the signal, and feeds

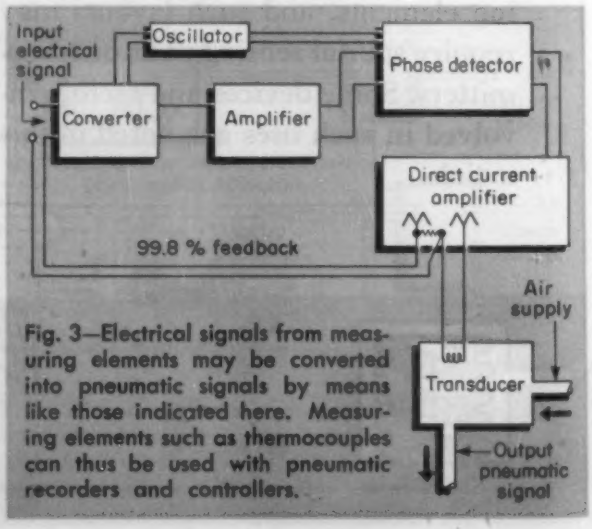

Fig. 3—Electrical signals from measuring elements may be converted into pneumatic signals by means like those indicated here. Measuring elements such as thermocouples can thus be used with pneumatic recorders and controllers.

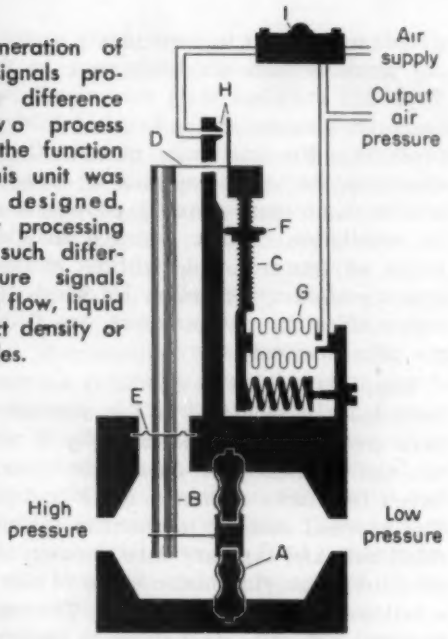

Fig. 4—Generation of pneumatic signals proportional to difference between two process pressures is the function for which this unit was specifically designed. With proper processing components such differential pressure signals may indicate flow, liquid level, product density or other variables.

it into a phase detector circuit. The resulting dc output is passed through a temperature-stable resistor and a transducer winding connected in series. Current through the resistor provides inverse feedback equal to 99.8 per cent of the input signal, thus minimizing the effects of amplifier variations and providing greater stability. Current through the transducer winding provides a magnetic force that positions a flapper-nozzle assembly in the transducer to produce an air relay output proportional to the original dc measurement. This output is fed back to a bellows to restore a balance of forces and is also transmitted to a receiving and/or controlling instrument.

Electrical Systems

As with straight pneumatic units, electric transmitters can also be considered according to purpose: General use, suitable for a number of different process variables; and single purpose, developed to handle a single variable.

Telemetering systems are a good example of multi-purpose transmission, suited as they are to many process variations such as flow, pressure, liquid level and temperature. In contrast with pneumatic transmission, telemetering may involve long distances of the magnitude encountered in reservoir checks for municipal water supply regulation, and flow and pressure readings along a natural gas pipeline. For instance, a new telemetering system—using an impulse-duration transmitter and receiver—can handle distances up to 150 miles by wire without repeaters or may be operated over radio or microwave channels.

Because the system operates as a function of pulse duration, the signal level can vary widely without affecting operation or accuracy. At 12-second intervals, the telemeter transmitter sends a pulse to the receiver proportional in duration to the variable being measured. The receiver automatically compares the duration of this pulse with that of the previous one and actuates a reversible motor which positions a recorder pen or indicator pointer to reflect any measurement change. The system uses relatively few moving parts, each of which is easily accessible and can be serviced without special tools. Also facilitating maintenance procedures are plug-in receiver relays and mercury-type switches which provide safe, reliable service.

Types for Specific Uses

Available pneumatic and electric transmitter designs include several so-called "universal" units which will handle more than one process variable, as well as specific transmitters manufactured essentially for a single variable. Some of the specific transmitters available are discussed in the following paragraphs.

Differential Pressure: Typical of instruments designed for a specific measurement but applicable to many other related variables is the differential pressure transmitter. While electrically-operated versions are available for specialized applications, the most notable differential pressure transmitter is the pneumatic type. Although differential pressure (pressure drop) is a variable in itself, it is widely used as an inferential indication of flow, liquid level and product density. Thus, the single-purpose differential pressure transmitter may handle a number of different plant assignments, transmitting 3 to 15 psi air signals to receiving instruments.

A force-balance device, *Fig.* 4, it operates in this manner: Pressures are applied to the high and

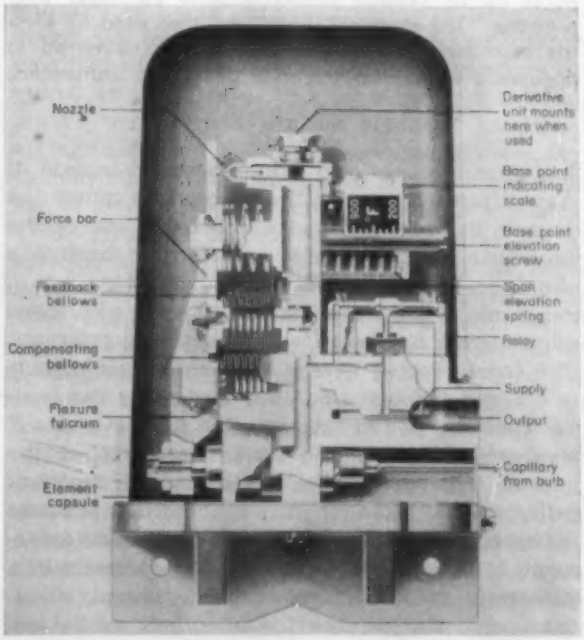

Fig. 5—This non-indicating transmitter produces pneumatic signals representing temperatures sensed by use of a gas filled bulb and capillary tube.

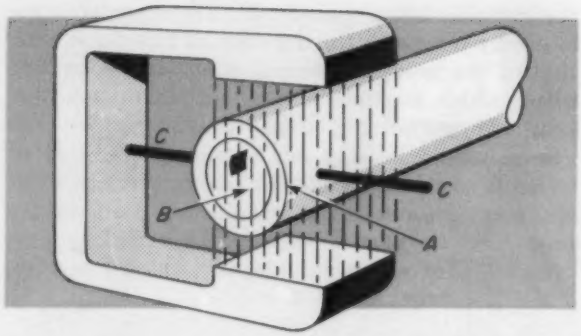

Fig. 6—Sketch of an electromagnetic flow sensing arrangement from which electrical signals can be obtained to indicate flow of materials in which turbulence, suspended solids and variations in conductivity, density or viscosity create measuring problems.

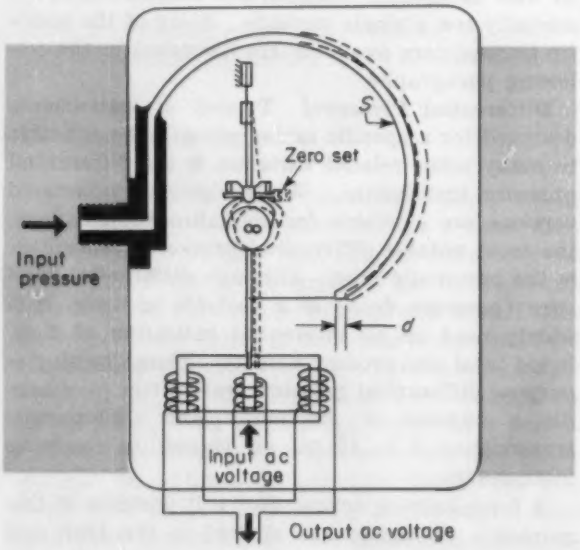

Fig. 7—One type of pressure transducer which produces an ac voltage proportional to the input fluid pressure. The electrical signals are then used by electric recorders or controllers or perhaps converted to pneumatic signals for use with pneumatic instruments.

low pressure sides of a twin-diaphragm capsule *A*. Any difference between these pressures causes the capsule to exert a force on the lower end of the force bar *B*. This force is balanced through a simple lever system consisting of the force bar *B*, range rod *C* and flexure connectors *D*; with metal diaphragm *E* and range wheel *F* acting as fulcrums. The force exerted by the twin-diaphragm capsule is opposed through this lever system by the feedback bellows *G*. In this way, the flapper-nozzle *H* compares the measured forces developed at the capsule with the forces exerted by the feedback bellows. Any change in differential pressure across the capsule tends to produce a minute movement of the flapper. This movement results in a change in output pressure at relay *I* and, simultaneously, changes the feedback bellows balancing pressure. The continuously adjusting bellows pressure maintains a state of force balance between bellows and capsule.

This instrument is particularly useful in processing work because its body may be forged from Type 316 stainless steel for overall resistance to corrosive streams and is rated at 1500 psi working pressure. Its small size permits the unit to be close coupled to process lines or vessels. Its total weight is no more than 21 pounds, a convenience in installation. Other features include a stepless range adjustment made without change of parts, and a self-damping action by which line disturbances affecting measurement are filtered out at the measurement source.

Temperature: Also operating on the pneumatic force-balance principle is the non-indicating temperature transmitter shown in *Fig.* 5. It will measure and translate for pneumatic transmission between the limits of minus 100 F and plus 1000 F. The thermal sensing mechanism includes the gas filled bulb and capillary tube common to most temperature measuring instruments in this range, and a bellows-type capsule element. The capsule exerts force on a flapper mechanism in proportion to the measured temperature. The resulting nozzle pressure, amplified through a relay and converted to a force through a bellows, balances out the capsule force and constitutes the 3 to 15 psi output to the receiving instrument.

Two additional forces act on the force bar. One is applied by the span elevation spring; the other is produced by the ambient temperature and barometric pressure compensating bellows. The spring adjustment lets the base point (temperature at which the transmitter output is 3 psi) be adjusted to the desired operating limit. The compensating bellows produces a force opposing that of the thermal system so that ambient temperature and pressure effects at the instrument will not be reflected.

Flow: Certain process fluids have been traditionally difficult to measure by conventional means. Typical examples are corrosive acids, rayon viscose, sand and water slurries, rosin size and detergents, each of which has presented flow measurement problems over the years. By application of Faraday's law of electromagnetic induction, a device has been made available that requires no restriction in the flow line and no pressure taps. It completely ignores such common metering headaches as turbulence, suspended solids, and variations in conductivity, density and viscosity. This magnetic flow meter produces an electrical signal proportional to rate of flow. The signal is transmitted by cable to an electronic receiver located up to 300 feet from the point of measurement.

The flow transmitter, *Fig.* 6 is composed of a nonmagnetic tube, *A*, through which the liquid flows, an electrical insulating liner on the inside of the tube, an electromagnet which induces a magnetic field, *B*, through the tube, and two metallic electrodes, *C*, which are essentially flush with the inside surface of the tube and which contact the flowing liquid. Liquid flowing through the tube acts as a moving conductor, generating an electric voltage which varies in proportion to the liquid's

average velocity. This voltage is picked up by the electrodes for transmission to the receiving instrument.

Pressure: Another device designed for single purpose application is the pressure transducer, a unit that converts fluid pressure into a proportional ac voltage which is indicated in terms of pressure by a resistance-type electronic instrument. The illustration of this pressure unit in *Fig.* 7 shows the principle of operation. Fluid pressure exerted on the Bourdon spring, *S*, results in a proportional displacement, *d*, of the spring tip. The tip moves a copper ring which surrounds the common iron core of the differential transformer. As the ring is displaced from its center position in the air gap between the common core and the input winding core, a proportional differential voltage is induced in the output winding. This voltage, which is also proportional to the fluid pressure imposed on the Bourdon spring, is applied to the electronic receiving instrument.

Such a device provides much speedier measurement and transmission than the conventional direct connected pressure tap and measuring element of a mechanically operated instrument. Where such speed is essential, such as in testing oil pressures in aircraft engines, this type of transmission is well applied.

▶ Selection Considerations

Choice of a transmitter for any specific application should depend on what function is to be accomplished at that particular process point. Distances from point of measurement to controller and from controller to valve should be considered in light of process behavior rather than arbitrarily or by rule of thumb. If hazardous areas are involved the necessity for explosionproofing electrical equipment must be considered. The speed of response demanded by the process is often a determining factor. Generally, a pneumatic link is preferred unless the capacity resistance lag it introduces is greater than that of the process to be controlled. Electrical transmission eliminates transmission lag and is particularly advantageous where the signal must reach a control room far removed from the point of measurement.

There is a strong and logical desire on the part of many instrument users to standardize on either pneumatic or electric instrumentation throughout the plant. It is felt that in this way fewer maintenance and service problems are encountered. This factor, plus the realization that a number of measurements must be made electrically or not at all, argues in favor of all-electric instrumentation.

In the larger processing plants, the marked trend toward electrical automatic data logging systems also favors the all-electric approach because these systems require that data be electrically received. Still another factor is the preference on the part of many control engineers for thermocouple or resistance bulb temperature measurement, for which electronic instrumentation is specified.

Each form of transmission has its own advantages and disadvantages, so that it becomes imperative to analyze these factors thoroughly before deciding on the type to be employed. Helpful, too, is an understanding of operating principles of each device so that accuracy, response speed and other characteristics can be evaluated with respect to actual design.

Integrating Springmaking

By P. F. ATWOOD
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NORMALLY, springs are bought on price, quality and delivery, and are shipped in containers which wad, snarl, and tangle them nicely. It is a real job to design and operate a machine to hopper feed them, as all tool engineers will testify.

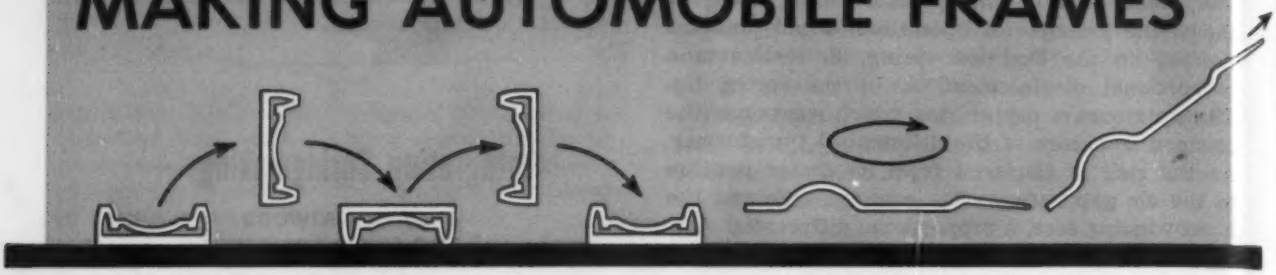
Years ago, the lock washer industry developed the non-linking type so that handling would be simpler and hoppers used where practical. The spring engineer, however, has not so easy a solution to this automatic handling problem.

Over the years, the spring industry has spent a lot of effort to increase output per machine, which means, more springs to tangle. The new solution is not for the spring maker, as we now see the machines. The future manufacturing of springs may well be that the cost of springs will be figured as the cost of springs installed in their operating position.

We must make the springs as we use them and run them from the spring machine into a unit mechanism or into a jig for heat treating or other processing, as required. The spring machine can be modified to cycle once and stop, if a spring is required as parts travel on a conveyor or dial. "Egg crate" box systems can be arranged to collect springs and hold them for assembly, if necessary, thereby eliminating snarling; or some other method can be used to keep the parts oriented for assembly. This "installed" method can reduce inventory of springs, allow springs to be fabricated as used; no excess inventory and no inventory of parts later found to be rejectable. In some cases, it might require that springs be fabricated right at assembly. Objections may be raised that we are stepping backward if we slow down machines. If we reduce costs it is justifiable and no doubt will allow the use of simpler machines since the initial fabricating unit would not need to be universal, and therefore, would be a less costly unit for our automated line. We must remember a simpler machine and a slower machine has many advantages, all in the line of reduced costs, less machine attention, less maintenance, fewer adjustments, since setups will continue as long as the line is in operation and no other springs are scheduled on these machines.

TUBE MILLS, BENDERS, WELDERS, AND HANDLING DEVICES COMBINED IN NEW PRODUCTION PROCESS FOR

MAKING AUTOMOBILE FRAMES



This extensive report of the automobile frame manufacturing process developed for a new plant reveals the potential realizable from the adoption of improved fabricating techniques and gives a clear view of the state of the art of automation.

By JAMES C. KEEBLER
Associate Editor

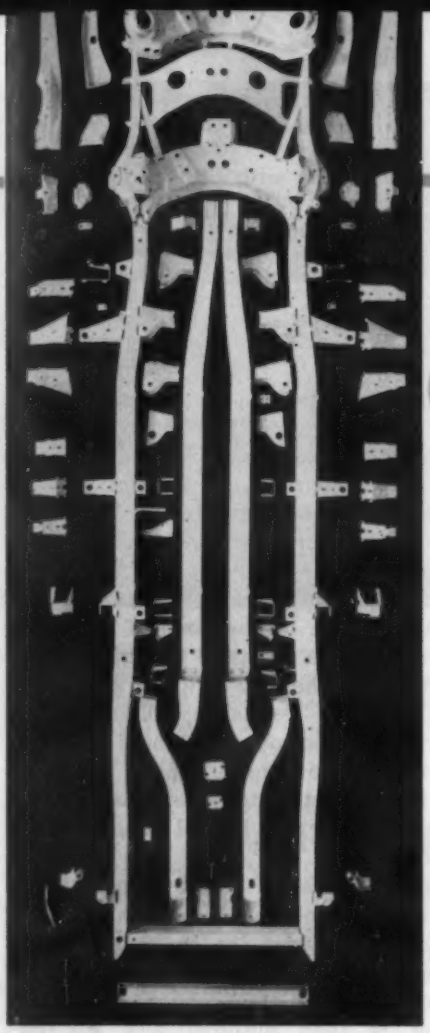
PROGRAMS FOR UPGRADING existing facilities are usually gradual in nature and slow at best. Dollars spent replacing existing equipment must show a savings over the alternatives of standing pat or making only minor revisions to present machines. At model change time, or in the course of tooling up for production of a new part, the master mechanic gets an opportunity to include some of the latest thinking in his production processes. Changes in product design make mandatory certain changes in production equipment. These changes can include desirable improvements in manufacturing methods at little or no extra cost.

Perhaps the greatest opportunity to make real advancements in manufacturing techniques occurs during a company expansion program that involves new plants and new manufacturing facilities. Chevrolet's decision to make frames in a new plant in Flint, Mich. provided just such an opportunity. Since the frame line was to be new from the ground up, and this division had never made frames before, the project was not hampered by limitations imposed by previous investments in machinery nor prejudices favoring "pet" methods devised years ago.

In the circumstance of setting up new production facilities there is always a certain temptation to take what is considered the easy way out and copy the methods in current use by existing fabricators. Although this plan would seem to eliminate the headaches of process and machine development, its very nature makes it impossible to reap the production and cost benefits possible with a completely new approach.

Departure From Tradition

Frames for modern automobiles use box-section girders as the outside members that run lengthwise under the car. The box girder shape provides the necessary strength, rigidity and flat surfaces required to mount chassis components and to carry the car body. Traditional method of producing these girders requires that steel strip first be stamped into two trough shaped lengths, or channels. Then these irregular shaped channels are assembled in pairs such that overlapping sections can be subsequently joined by submerged arc welding. Key to the thinking behind the new process of manufacture was the potential gains to be



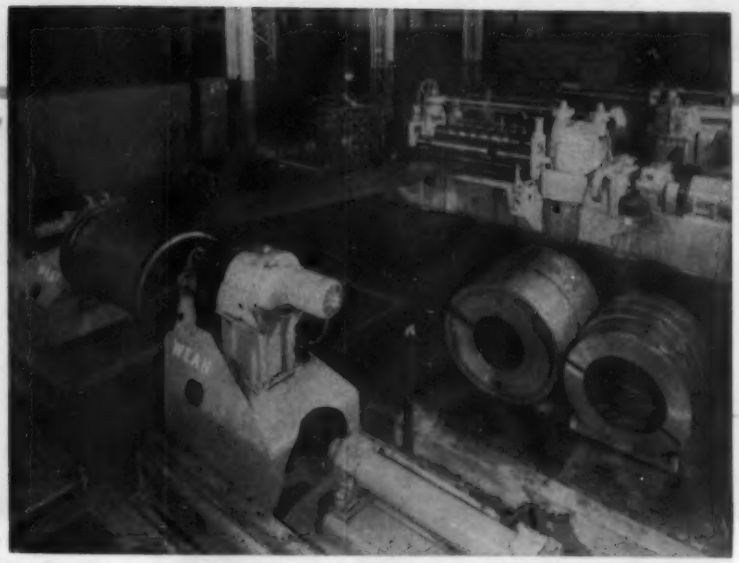


Fig. 2—Wean coil slitting equipment produces strip with squared edges in the required widths for tube-mill operations.

Fig. 1—Assembled Chevrolet frame and the component details of tubing, castings and stampings of which it is made.

realized by making the box section from coil stock on a tube mill.
Advantages include:

1. Standard tube mills of the type required can form and resistance weld tubing at the rate of 150 feet per minute as opposed to average submerged arc welding speeds of 60 to 70 inches per minute common to the overlapping channel method.

2. Tubing made by this process would not require the huge presses necessary in making stamped channels.

3. Handling and raw material requirements would be reduced.

4. Tubing would have greater rigidity than the built-up box, and weigh 4½ pounds less by eliminating the overlapped portions.

Achievement of these benefits however was contingent upon finding suitable means of bending the straight lengths of tubing into the contours required by the frame design, and doing so without causing it to buckle or collapse. Experimental processing showed that these problems were not insurmountable, and the manufacturing development program for the new frame plant moved ahead under the basic concept of the new plan of fabrication.

The product redesign required to permit this new method of manufacture involved changing the detail parts of the frame but not the functional configuration of the final assembly. This allows full interchangeability with frames from other methods of manufacture.

Frames made of tubing consist basically of two welded four-piece side girders, two cast steel spring brackets, twenty-one chassis component and body mounting brackets, one riveted front cross member assembly and one stamped rear cross member, *Fig.* 1. The front part of the side girder is 4.0 by 4.5-inch welded tubing 102 inches long, formed and bent to the required configuration. The rear part of the girder is 2.75 by 3.5-inch welded tubing 51 inches long, bent to "kick up" over the rear axle. These two tubes are joined by a transition piece 13 inches long which is made of two channels welded together. All details of the side girder assemblies are made from stock 0.090-inch thick.

▸ Planning Policy

Development of the new frame started 14 months before the introduction of the 1955 Chevrolet. The new plant went into operation in December of 1954.

The metalworking machines, controls and handling equipment used were planned with an eye toward relieving the production workers from as much of the heavy labor of moving frame parts

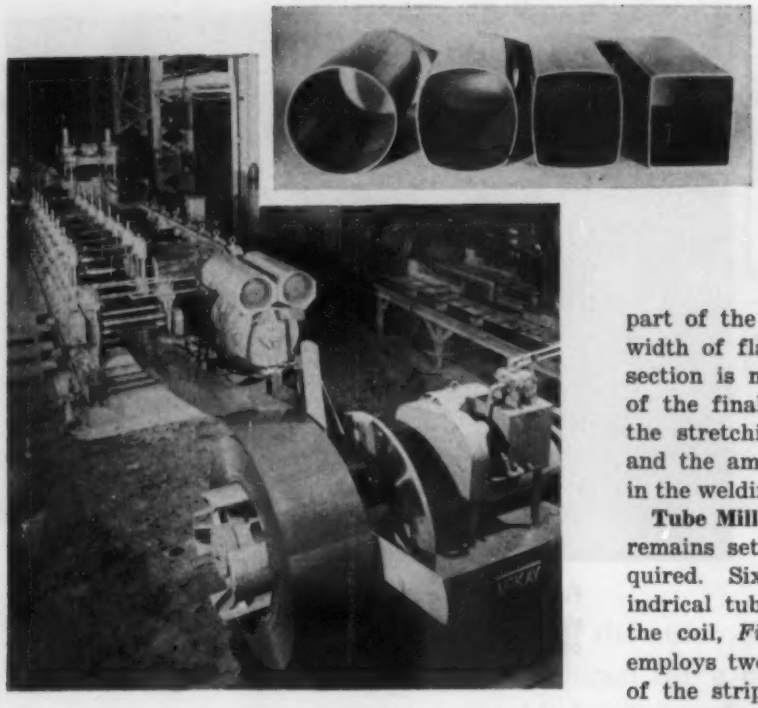


Fig. 3—McKay tube mill forms the strip into a cylindrical section and resistance welds the joint. "Turks head" unit sizes tubing into rectangular section and flying saw cuts it into lengths. Insert shows stages of transition from round to rectangular shape.

and assembled frames as is now feasible for this type of operation.

Although many people may consider the auto industry as having long-run stable production, it must be remembered that changes in styling in major model change years cause serious disruptions in frame production lines. Frame designs yet to come may be such as to require totally new machine tools for sections of the line. For this reason extra equipment intended to raise the level of automation in this line must either be able to pay its own way within the contemplated time assured the present design or be so universal as to insure usefulness for years to come. The equipment selection advantage enjoyed in opening up a new plant operation is not a perennial blessing.

▶ Production Operations

To better understand the considerations involved in this manufacturing process it is well to look at the major operations in the production sequence and discuss some of the important points of each.

Coil Slitting: Stock is purchased in wide coils and slit into narrower strips, *Fig.* 2. This operation produces strip with squared edges that will butt each other after forming in the tube mill, and thereby produce a good welded joint. Stock is recoiled on the take-up end of the equipment, and these coils are used to feed the tube mills.

Two widths are involved here, one for the larger rectangular section used for the front part of the girder and the other for the smaller section used in the rear. Exact width size determination was part of the process development program because width of flat stock required to form the finished section is not only dependent upon the perimeter of the final development, but is also affected by the stretching and upsetting effects of the rolls and the amount of "burn off" material consumed in the welding.

Tube Mills: This plant has two tube mills. Each remains set up for one of the sizes of tubing required. Six roll stands are used to form the cylindrical tubing from the flat strip as it pays off the coil, *Fig.* 3. The resistance welding station employs two rotary electrodes that hold the edges of the strip together during fusion of the metal. The welding flash upset material is removed from the outside by a shaper style tool mounted after the welding station.

The tubing continues at 150 feet per minute through final sizing rolls into the "turks head" unit where in three stages the shape is changed to the required rectangle. The forming operations are all cold working of the steel.

This tubing is then automatically cut into lengths by a flying saw that clamps onto the tube and moves along with it while feeding across the cut, *Fig.* 4. Upon completion of a cutoff stroke the saw rapidly traverses back to the tube mill and picks up the next length for another cut.

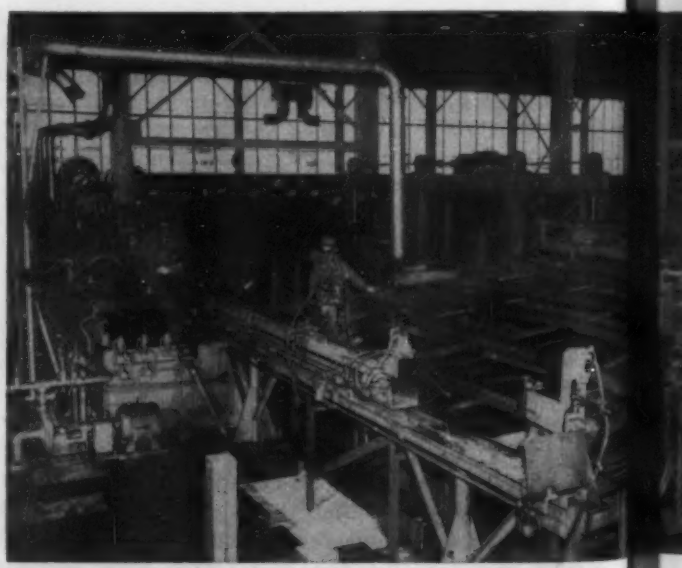


Fig. 4—Flying saw equipment discharges 204-inch lengths of 4 x 4½-inch tubing onto the transfer conveyor. Stacker is shown in the rear.

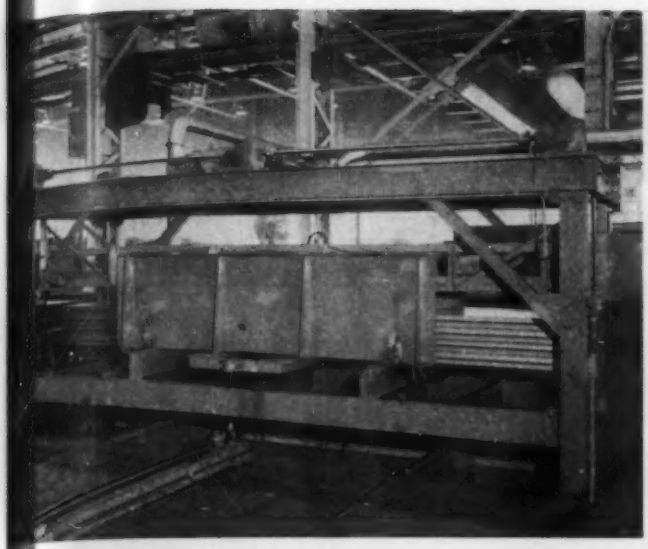


Fig. 5—Tube production in excess of immediate line requirements are loaded for storage by this stacker built by Planet Corp. Stacker feeds tubes back into the line when tube mill is not running.

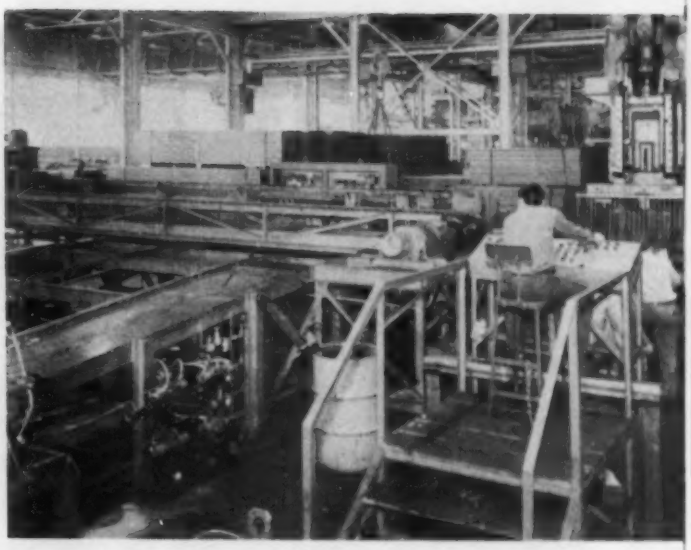


Fig. 6—Master control station of the Planet Corp. equipment regulates movement of tubes into the cut-off press in the right background, and into and out of the storage stacker to the left.

Handling and Storing: Automatic production of tubes is performed at a rate in excess of the rate the remainder of the line consumes these tubes. To equalize this difference a given tube mill is run only part time and the tubes in excess of immediate production requirements are delivered to a stacker, *Fig.* 5, that accumulates a unit load.

The cradle of the stacker indexes downward as each row of tubes is received. When the stacker cradle is completely loaded it is automatically discharged by a cradle transfer mechanism. Another cradle takes its place in the stacker and moves into position to receive a new load of tubes. An overhead crane moves the banded load into a storage area until they are again needed. This stacker unit is designed such that it can unstack a load of tubes and feed them back into the line, acting as the source of material when the tube mill is not operating. This section of the line is controlled by an operator at a master control station, *Fig.* 6.

End Squaring: Next operation in the sequence performed on the large tubes is to cut each in half with a punch press. The tooling is such that a

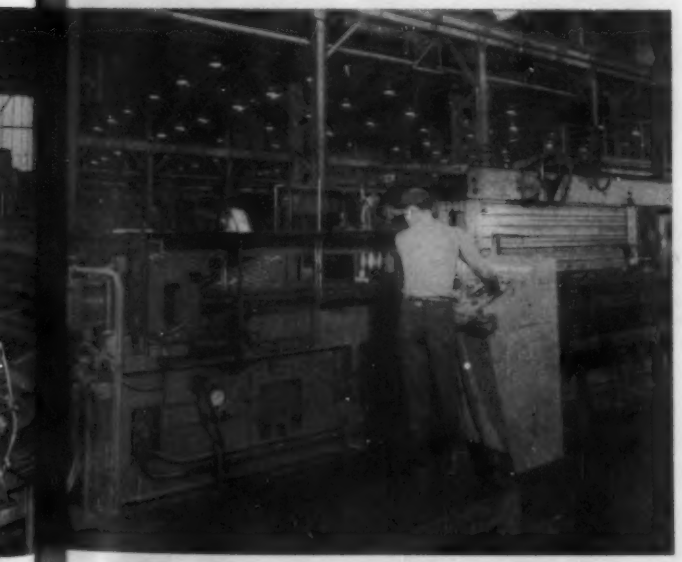


Fig. 7—Danly built machine re-forms end of tubes to 2.88 by 5.62-inch size using hydraulically actuated expanding mandrels.

Fig. 8—Close-up view of re-forming machine shows right-hand mandrel ram in load-unload position and left-hand ram in expander position.

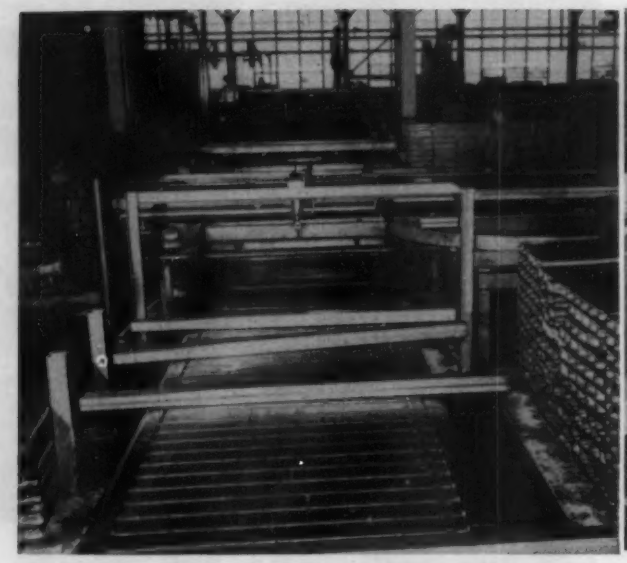


Fig. 9—Turntable at right rear discharges tubes onto a drag chain distribution conveyor which feeds the re-forming machines. Tubes are then fed onto the flat conveyor for transportation to benders.

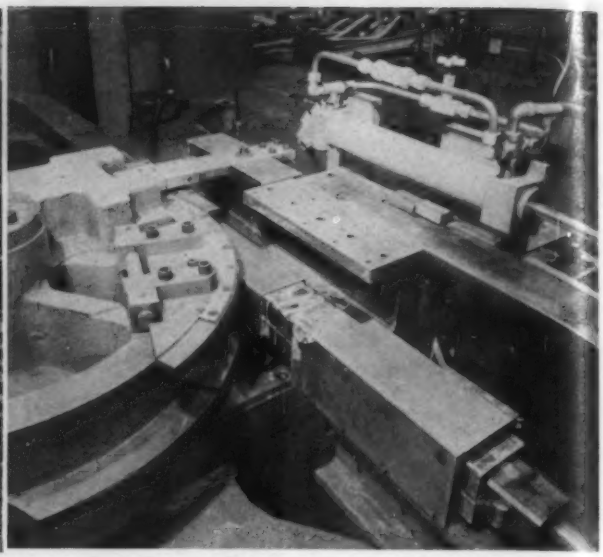


Fig. 10—Close-up view of the Pines Engineering Co. bending machine that puts the bend in the rear of the large tube. Articulated mandrel is being inserted into clamped end prior to the bend.

slit is cut out across the top of the box — this allows a punch to enter from the top, slit down the sides and pierce out the bottom. This makes two pieces 101 inches long, each having one end whose edges are squared. This edge is a truer surface than that produced by the flying saw and is used for subsequent locating. To cause each piece to enter the line with the same end leading, the conveyor following this press operation has a turntable which automatically turns every other piece end for end.

Transposition of Perimeter: Design of the large tube requires that the front portion near the engine have a 15¼-inch length whose section is 2.88 by 5.62 inches, and then taper for a length of $14\frac{3}{16}$ inches back to the 4.0 by 4.5-inch basic size. This is performed on a machine that uses hydraulically operated wedge shaped mandrels to expand the tube width in one direction, at the same time decreasing the thickness in that length, *Figs.* 7 and 8.

Tubes are fed from magazines above the table on each side of the machine which has two mandrel rams that shuttle between the load-unload positions and the expander position. As the tube on the left-hand ram is being re-formed in the expander position, the right-hand ram is in its load-unload position where the previously re-formed tube is stripped off and the next tube is loaded from the right-hand magazine. As these operations are completed the work table indexes to the left, placing the left-hand ram in its load-unload position and the other ram in the expander position. Here a like sequence takes place, loading a new tube from the left-hand magazine, and re-forming the tube on the right-hand ram. These cycles repeat automatically under the direction and surveillance of the operator at the control panel. Tubes are conveyor transported to and from this operation, *Fig.* 9.

Tube Bending: This straight tube of varying cross section must be bent such that the front goes in and up by the engine and the back goes up over the rear axle. At this stage of production the tubes becomes either left-handed or right-handed.

Bending operations required the greatest amount of process development work of any of the operations on the frame line. Not only was this tech-

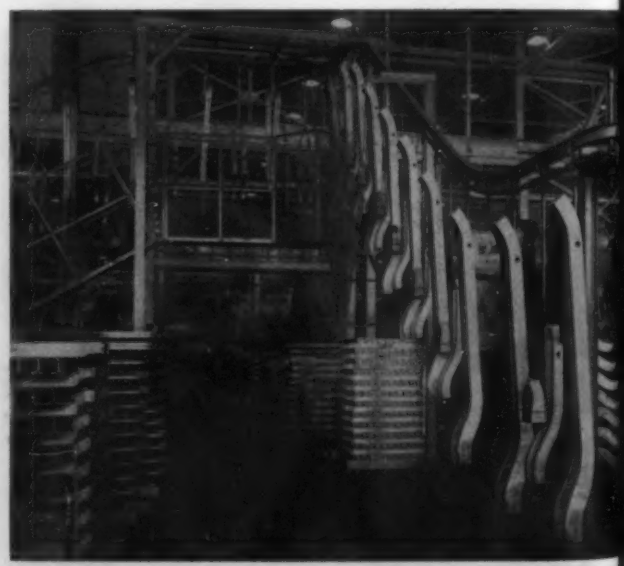


Fig. 11—Planet multistory trolley conveyor receives front and rear tubes and transition pieces from their production lines and supplies them to the welders that join them.

nique new to framemaking, but the bending of such large irregularly shaped pieces was a new problem for the art of bending. The tolerances on sheetmetal thickness affect the operation in that the tube mill rolls work strictly on the outside of the metal and the inside dimensions thereby vary by twice the metal thickness tolerance.

Experimentation showed that five bends were required on the front tube and two on the rear tube to achieve the desired shape. It was also determined that the inside of the tube should be as completely filled as possible with articulated mandrels whose short sections were linked together in such a manner as to permit them to flex as the tube was bent around an external die shoe, *Fig.* 10. In the front section where the inside dimensions vary, these articulated mandrels become quite complicated. One such mandrel is of sandwich type construction in which the main hydraulic cylinder first inserts the two outer sets of links and then the center set is moved in by an auxiliary cylinder in such a manner that the outer links are wedged out to fill the tube cavity. Another bend in this portion of the tube uses a "piggy-back" type mandrel in which the second section of the mandrel is inserted after the first and must climb up over the first part to get into bending position. The complexity of this tooling is shown by the fact that none of these front-end bend mandrels can be used for more than one operation, and one of them consists of 70 details that make up the tool-steel mandrel assembly.

These bending operations are among the few in this plant where each tube is loaded and positioned by hand. The machines are of the automatic cycling type in which the parts are clamped, mandrels inserted and tubes bent as part of the cycle.

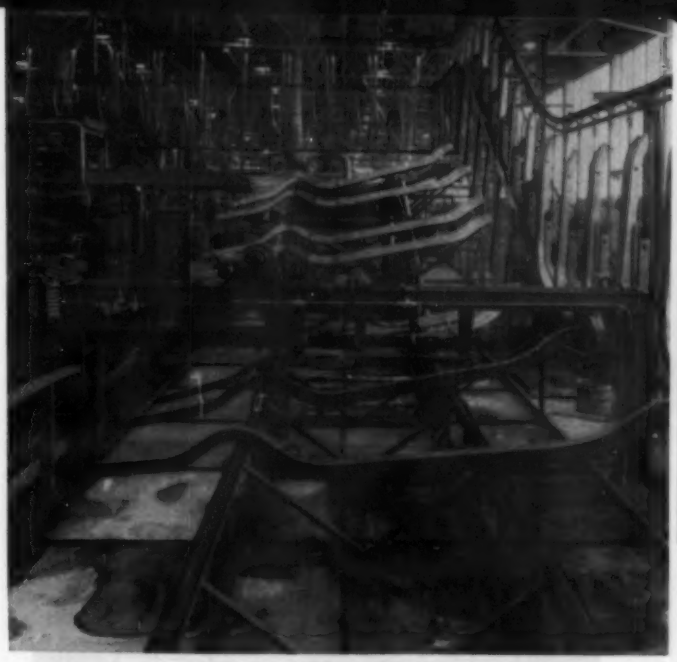


Fig. 13—Conveyors take the girders from the side hole drilling operation to the projection welders that fasten on the brackets.

Similar bending operations are performed on the shorter rear tubes.

Completing the Tubes: To make the large tubes ready for assembly they are processed through a press line where holes are pierced; ends are formed, sized, and trimmed; and stiffening spacers are inserted in the openings to insure proper mating with the transition piece.

At this stage the front and rear tubes and the transition pieces get a ride on a trolley conveyor system that serves as discharge point for their respective production lines and as material feeder

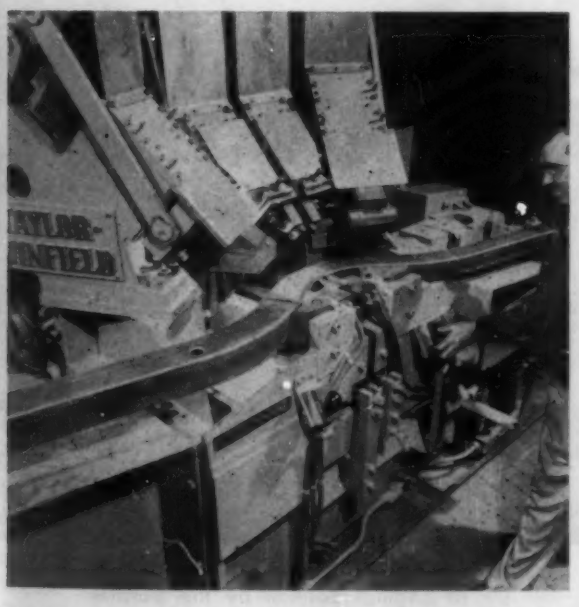


Fig. 12—Flash welders made by Taylor-Winfield join the three sections of the box girder together.

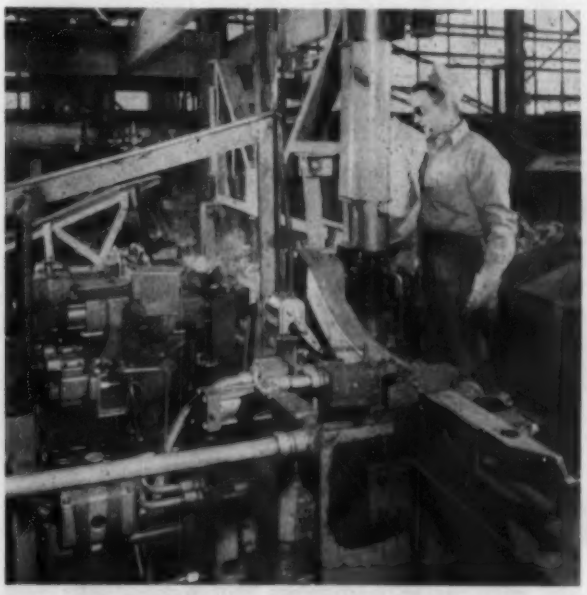


Fig. 14—Projection welding machines tack the brackets onto the girders.

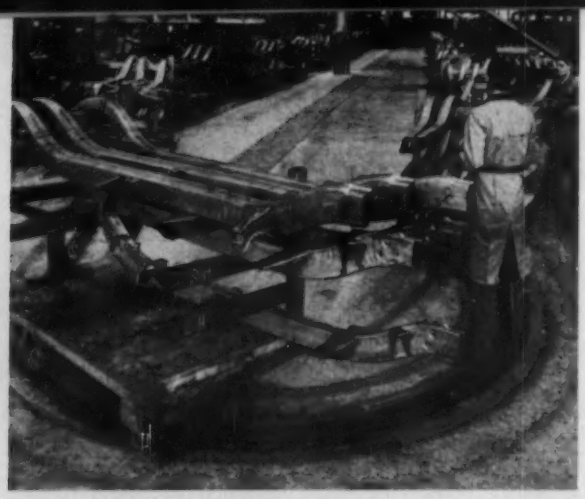


Fig. 15—"Mobile warehouse" receives finished work from the projection welders and provides material supply for the frame final assembly line.

Fig. 16—Locating fixtures for assembly of front and rear cross members to side rails are setup across the head end of the final assembly conveyor.

for the welding machines that will join them together. This conveyor is a continuously moving storage bank which receives parts onto any empty hanger and retains them until taken off for the next operation, *Fig.* 11.

Flash Welding: The three pieces of the box girder are welded together by flash resistance welding machines. *Fig.* 12. Locators and electrodes are mounted on the machine platens which operate in such a manner that as the secondary current in the welding transformer is automatically cut off, the edges of the sections being joined have reached a plastic state and are moved together to create a welded joint. Machine sequence is such that the front tube is first welded to the transition piece and these in turn are welded to the rear tube.

Bending and tensile tests have been conducted on the resistance-welded seams and the flash-welded end joints and they are consistently stronger than the parent metal.

Drilling the Girders: As the completed girders are ejected from the flash welders they are transferred to multispindle horizontal drilling machines that automatically drill 14 holes in the left-hand girders and 18 holes in the right-hand girders. These holes go through the side faces and serve in the attachment of clips and location of brackets. The left-hand and right-hand girders are flash welded and drilled in separate areas of the plant on machines that are similar but of opposite hand. Completed girders are moved by conveyor, *Fig.* 13, to the next operation. The design of these conveyors is such as to raise one end high enough to allow drilling coolant to drain out while the parts are in transit.

Projection Weld Brackets: Transfer mechanisms take the girders from the conveyors above the

Fig. 17—Final assembly conveyor built by Planet Corp. has repositioning mechanisms that automatically turn the frame 90 degrees at a time to present all surfaces to the welders as the frames move down the line.

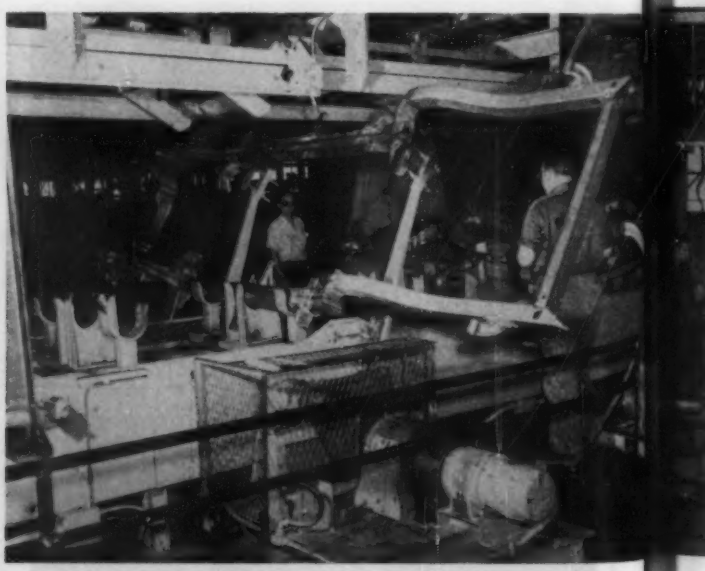


Fig. 18—Frame is laid back down to original position by the transfer device at the last stations of the final assembly welding line.

projection welding machines and drop them into place in special fixtures that locate the girder and the brackets which are to be fastened to it. Separate machines are provided for left and right-hand girders which get 11 and 10 brackets respectively. The brackets are hand loaded and automatic cycle initiated by the operator, *Fig.* 14. Weldhead controls are set to sequence such that all welds do not take place simultaneously.

All projection welding machines are serviced by a "mobile warehouse" which is a train of four-wheeled carts pulled by an in-floor conveyor. These carts are equipped with racks whose tiers are identified for left and right hand girders, *Fig.* 15. The projection welder operator places finished work on any passing cart having an empty spot on the tier that is identified for the particular side girder his machine handles. The girders continue to circulate on this train until the operators who are loading the frame final assembly lines remove a pair for each frame being put together.

Frame Final Assembly: These two side girders are placed on the final assembly conveyor and joined to the front cross member (a riveted assembly made elsewhere in this plant) and to the rear cross member stamping. These components are properly located with respect to each other in special fixtures which are set up at right angles to the conveyor, *Fig.* 16. This and subsequent welding operations are all hand arc welding.

The conveyor moves past all welding stations and each operator does his appointed part of the complete welding requirements. Various types of filiet, tack, and puddle welds are used to securely join each of the previously tacked brackets to the side rails. As the frame passes along the conveyor it is automatically repositioned 4 times

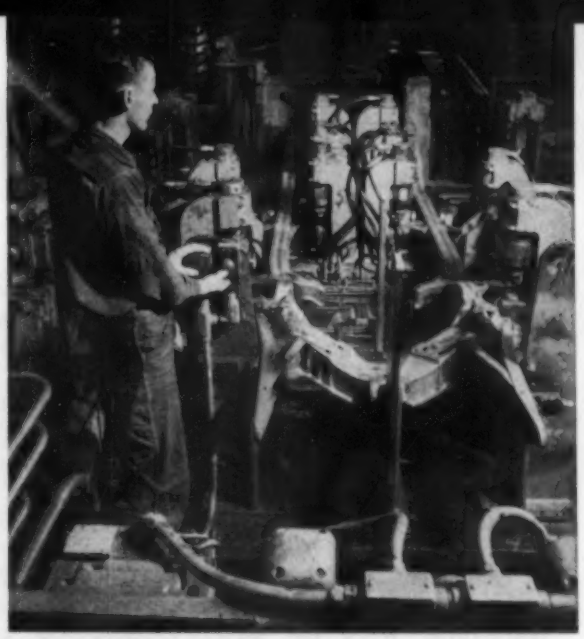


Fig. 20—Danly piercing unit for 12 body-mounting holes. View shows heads in retracted position after piercing.

into successive 90-degree positions, *Fig.* 17, so that by the time it reaches the end of the line it has made a complete 360-degree revolution, *Fig.* 18. This provides for all welding to be done in a horizontal plane.

The conveyor serves to pace the welders and to present the work to them in a convenient position. There is no need for a welder to assume an awkward, tiresome stance; and of more importance, the manual lifting and hauling formerly required by this type of work has been eliminated.

Pierce Body-Mounting Holes: Another of this plant's significant processing improvements is the

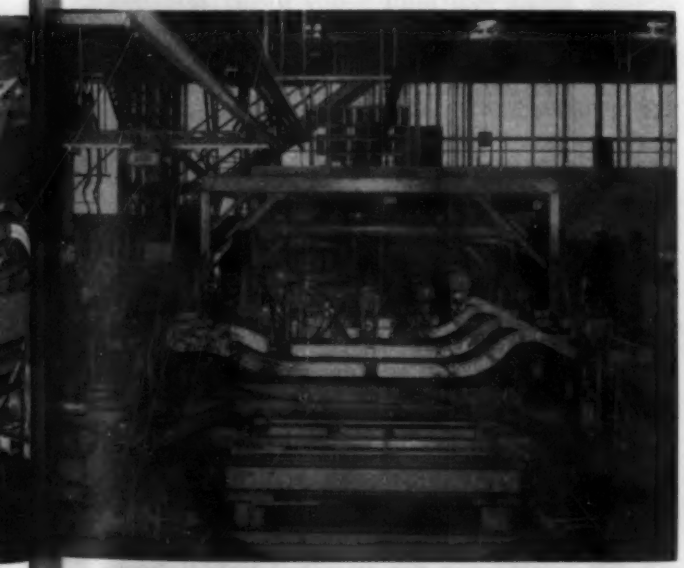


Fig. 19—Walking beam transfer mechanism built by Wilson Automation moves frames into piercing unit. Overhead transfer carriage made by Mechanical Handling Systems Inc., removes the completed frames.

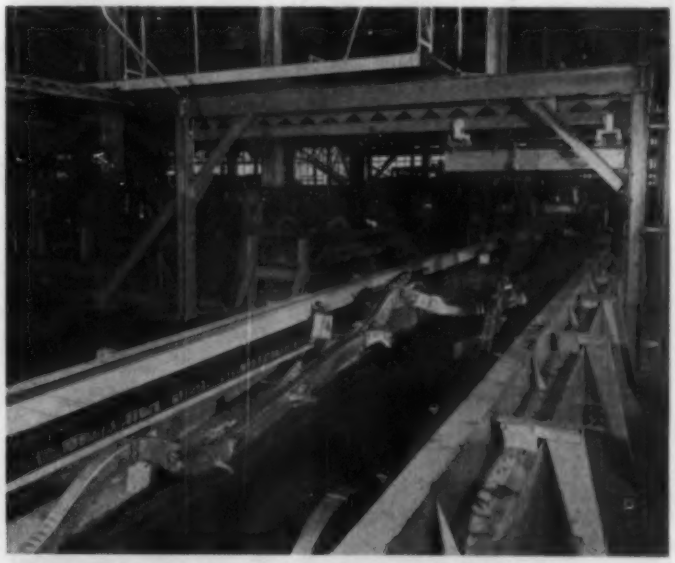


Fig. 21—Overhead transfer carriage is synchronized to lower the frame so that conveyor hooks engage cutside frame brackets. Interlocks prevent delivery of frame into conveyor station that is already occupied.

method of locating the body mounting holes. Traditional methods put these holes in the brackets before they are fastened to the girders. Because the brackets cannot be located on the girders to extremely close tolerances, due to conditions inherent to welded assembly, it was decided to pierce all of these holes in one operation after the final assembly operations have been completed.

Details of production were worked out in such a way as to have ½-inch holes in the brackets as component details and use these as construction or location holes where required in earlier fabrication. When the final 1¼-inch holes are pierced in true location with respect to each other, this smaller hole comes out in the slug. Any minor mislocation of the bracket is reflected only as a mislocation of the final hole with respect to its own bracket and not as a misposition of this hole with respect to the mating body, as was traditionally the case.

For this final piercing operation, frames have been moved from the end of the final assembly conveyor and placed in the loading position of the piercing unit. This transfer mechanism is of the walking beam type that lifts the frame, moves it sideways over the piercing heads, lowers it into the equalizing fixture, and traverses back to the loading position to pick up the next frame, *Fig.* 19.

When the equalizing fixture has located the frame in the optimum position, the hydraulic C-type punch and die units move horizontally into piercing position on their individual slides, *Fig.* 20. The action of these heads causes the lower anvil to rise until it contacts the underside of the bracket. This contact stops the movement of the lower die and builds up a pressure in the hydraulic actuator system that trips the punch which then descends, piercing the hole in the bracket. Individual action of the heads in seeking the vertical position of each bracket eliminates the possibility of distortion that could occur if all anvils were in a fixed solid vertical location.

The result of this operation is that Chevrolet can achieve the most distortion-free body-to-frame mating yet accomplished. Any horizontal mislocation of the brackets is compensated for by the fact that each piercing head can operate only

Fig. 22—Transfer point where timing hooks receive the upended frame and place it on a hook of the trolley conveyor of the cleaning and painting system.

Fig. 23—Frames travel in vertical position on trolley conveyor system that twists nearly a half mile from the ground floor to the roof of the plant and back again, delivering frames to the shipping dock after carrying them through a washer, dryer, paint booth, drain section, and baking oven.

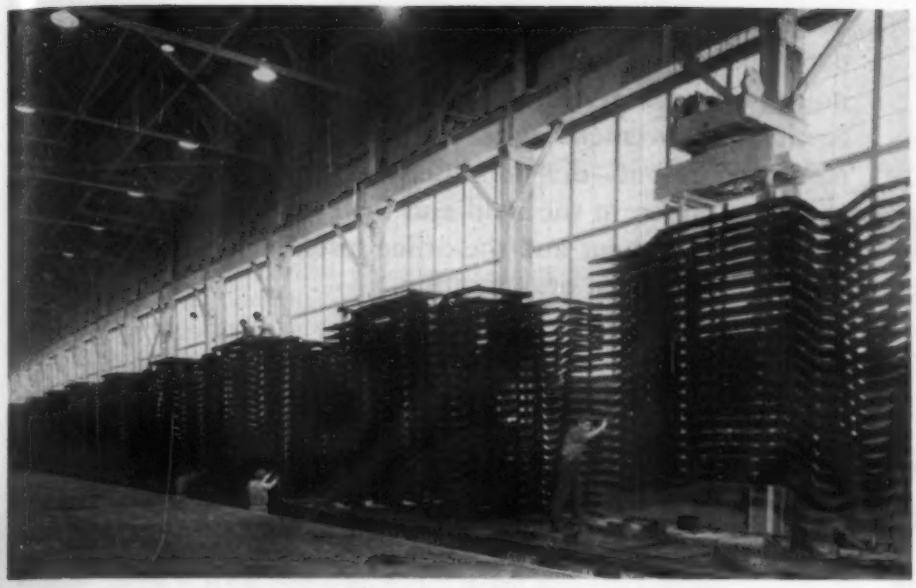


Fig. 24—Chevrolet frames are loaded on flatcars for shipment to assembly plants.

when in proper location, and any vertical mislocation is handled not by bending the brackets but by use of body shims at the assembly operation.

An overhead carriage transfer unit with arms that reach under the front and rear cross members, lifts the completed frame out of the piercing unit and is synchronized to deposit it on a conveyor. The entire piercing sequence, including the loading and unloading, is programmed to cycle automatically. Proper functioning is observed by an operator who can handle special circumstances at his switching control panel. The final quality size check is made at this point with the prescribed percentage of production being pulled off the line for master gage inspection.

Finishing: Just as all final assembly welding lines converge into one of two identical final piercing setups, these two setups each deliver their frames to a common conveyor that supplies the single finishing conveyor line. Since the frames completed in one piercing station are conveyed past the other piercing station on their way to the finishing conveyor, this point of intersection must have electrical interlock protection so that the overhead carriage does not deliver a frame into a conveyor station that is already occupied by a frame from the other piercing unit. In such a situation the interlock control delays delivery of the frame until an empty station approaches. The carriage arms synchronize with that station and lower the frame so that the chain mounted hooks engage the front frame brackets and drag the frame away, *Fig.* 21.

The end of this conveyor is so constructed that the frame is raised on end at a transfer point where timing hooks receive the frame, *Fig.* 22, and place it on the approaching hook of the trolley conveyor that will carry it through the automatic cleaning and painting equipment, *Fig.* 23. Completed frames are ready for shipment to Chevrolet assembly plants at various locations in the nation. Stacked 20 high, they are loaded 120 to a flatcar, *Fig.* 24.

Summary

The benefits achieved by this new production process include savings in manufacturing costs through greater efficiency. Not only are the production operations less costly, but these methods better utilize the raw material. In the frame operations only 19 per cent of the metal goes into the scrap balers.

Although such advancements are always significant, they are doubly important when the new method also produces a product whose performance qualities are superior to those made by previous methods. Inspection results show the frames to be exceptionally accurate dimensionally, and tests prove them to be 50 per cent more resistant to the torsion, or twisting, caused by rough driving than were their design predecessors.

The task of refining and improving these manufacturing methods in keeping with future advances in processing should provide an interesting challenge to mechanical ingenuity, as has the original development of the present techniques.

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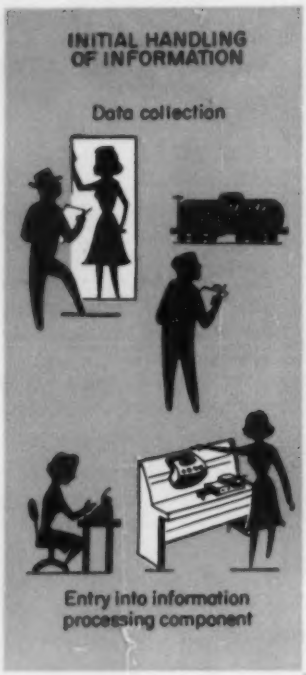

Executives are examining the office in light of its cost and contribution to the business endeavor. Application of technology to administrative control seems to offer them potential improvement equal to that in process control. One point stands out—divisions between office and factory, between salesmen in the field and their office support, and between management and the office often lack positive resolution in the modern organization.

AUTOMATION SPURS THE CHANGING OFFICE

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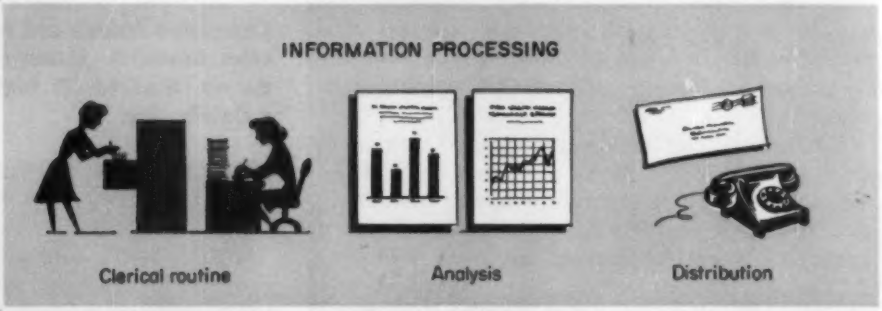

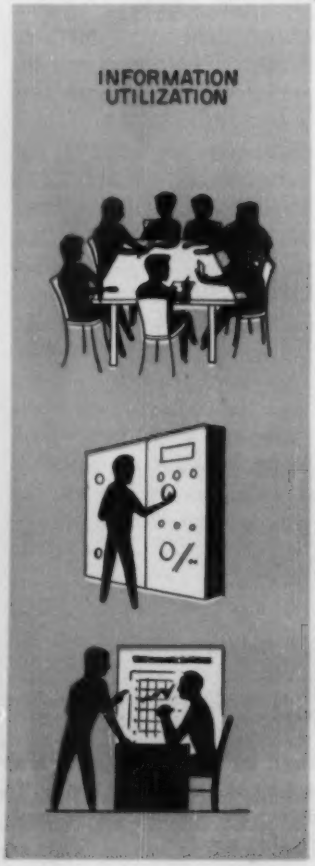

Fig. 1 — Three-pronged assault on business problems may be made through new means for initial handling of information, new methods for processing information, and new techniques for utilizing information.

THREE MAJOR ASPECTS of information handling—initial handling, processing and using—have a powerful technological tool available in each. The initial handling of information is an area in which common language machines simplify preparation of basic documents and eliminate the need for recopying to serve other purposes within the office. Electronic computers are bringing about a new era in business information processing. Scientific inquiry and a vast body of scientific knowledge stand ready to aid the administrator in using information. Thus, in the initial handling, in the processing, and in the using of information we find developments having important impact on business operations, *Fig.* 1.

Considerable enthusiasm is developing for integrated data processing, computers, and operations research. Such ardent interest is well placed. But emphasis on the benefits of technology must not replace consideration of the time and investment

This article is based on the forthcoming book by Mr. Levin, "Office Work and Automation" to be published by John Wiley & Sons Inc., N. Y., N. Y.

required to achieve those benefits. Much that has been discussed is promise rather than achievement. While common-language machines may be applied today, computers are a tool that will reach maturity tomorrow. In the same light operations research will reach fruition the day after tomorrow. The basis for such a generalization lies in the respective complexity of these tools.

There is little serious bar to use of common-language machines. Careful procedures planning can achieve many rewards. Computers also require procedures planning but it is of a different order of magnitude. Programming is a barrier to extensive use of computers in the office. Yet this barrier is lifting under a concerted effort by manufacturers and users of computing equipment.

Operations research has the greatest scope of the tools we have discussed. It reaches into all aspects of business operation and strives for the best course under each set of business circumstances. This is a difficult goal, and it is not surprising that operations research is a complex discipline. Use of operations research is slowed because management understanding is incomplete and because operations researchers are yet few in number. It is also impeded by our inability to measure many phenomena on which decisions are based and by our imperfect knowledge of how people reach decisions.

Technology will have considerable effect on the office. As information becomes more available, more timely, and more economical to obtain, we can expect changes in management concepts and business operations. The flavor of scientific inquiry will add the dimension of more questioning attitudes at all levels of management. Absolute requirements of past decades may be set aside under new concepts of business management.

Control in a Changing Office

From a management standpoint, the most important effect of technology on office work will lie in increased control over the affairs of business enterprise. Control can be thought of as existing at two levels. There is the day-to-day operation of the business in accordance with stated or implicit policies of the company. This might be termed operational control. There is another layer of control, management control, in which policies designed to further the objectives of the firm are set.

The purposes of management and operational control may appear separate and distinct. However, we cannot draw a sharp line between these elements of administration. They are in fact closely interrelated. Ideally, the results of operational experience within a policy framework should be fed back for consideration of policy change. Thus, the management decision to sell a particular item in a certain quantity would be subject to modification as sales experience with the item occurs and other operating facets of the sales and manufacturing program develop.

Policy reflects objectives of the firm—operations, in turn, reflect policy. Thus, operations are designed to achieve the objectives of the firm. The degree to which operations successfully accomplish this aim can be determined from study of operational information. Documentation of operating control is the raw material on which policy or management control is based. The tools we have discussed will provide several gains in linking operations to policy determinations. Through use of the common language concept and electronic computers, timely, comprehensive, and economic information drawn from the day-to-day affairs of the business can flow to policy makers as a matter of routine. Further, operations research will provide useful guideposts for interpreting information and relating it to policy or operating decisions.

Business information systems under the impact of new tools can apply the principles which underlie the automatic control systems found in oil refineries and guided missiles. Automatic control occurs in a system in which information on system behavior is compared with a desired goal. Discrepancies between performance and that goal are used automatically to adjust system behavior. The fundamentals of an automatic-control system are sketched in *Fig.* 2.

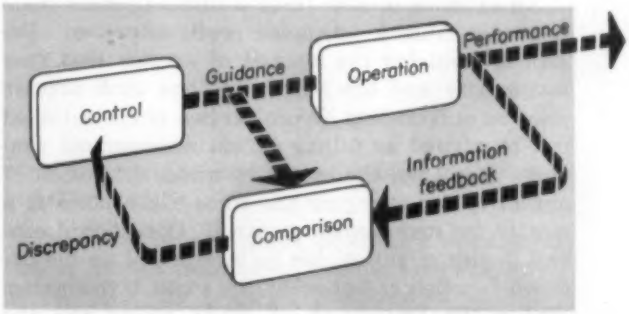

Fig. 2—Elementary block diagram of an automatic control system. While this dicgram was not originally intended to suggest office operations, the principles indicated have application to office work.

We are some distance from an automatic office. However, the principles of automatic control have application to office work. Information feedback is already an important element in current business systems. It may be that pressure of unwieldy clerical systems has prevented general recognition of this fact. The abstractions that could be drawn from current business information handling systems have been hidden under a mountain of papers and several baskets marked "Rush."

Common language machines, electronic computers, and operations research all contribute to use of information in control of business situations. This control can have many of the elements found

in *Fig.* 2. It is even conceivable that the cryptic message "Smith cancelled" could be used in conjunction with mathematical models and electronic computers so that a revised production schedule, recalculated inventory levels, amended purchase orders, and adjusted sales forecasts are automatically prepared. The extent to which this automaticity will be achieved depends on the stakes involved in achieving it. In most cases it will be practical to settle for something less in self-regulation of office work.

While new tools for office work will not bring a pushbutton office, they can bring a greater flavor of automatic control to business information systems. Three elements of control and the role of information feedback in regulating the interplay among these elements are illustrated in *Fig.* 3.

An example of how these controls operate could be taken from a telephone credit situation. Decisions involving the amount of arrears that may accumulate and the length of time such arrears may be outstanding before service is discontinued can be viewed as falling within management control. Similarly, the extent to which delegation of authority for changing the rules takes place is a matter for management control. Operational control in this situation can be interpreted as the decision function exercised by the credit investigator. Within the framework of credit policy and the limits of discretion left to the investigator, the investigator must decide whether to discontinue service or take other action to protect company funds. Performance measurement could be based on the per cent of accounts in arrears, total receivables, cost of the collection activity, and such other figures as had demonstrated importance.

The information chains sketched in *Fig.* 3 can be strengthened. The extent to which this occurs will measure the effectiveness of the tools we have discussed. Feedback of information for control purposes is not new in the factory or office. But the exploitation of this principle in production of physical goods far exceeds the applications we find in office work situations. Common language machines and computers make information more readily available and less expensive. Computers can use statistical techniques for automatic detection of significant variations. In this way attention can be directed to areas in which management action is needed. Operations research provides for objective evaluation of business information. Further, it offers flexibility for management planning. Alternatives can be tested by manipulation of numbers and symbols. Time factors, cost factors, and avoidance of risk argue strongly for use of mathematical models where they can adequately represent the economic, physical, or organizational structure of the firm.

Adjustment to Change

The combination of common language machines, electronic computers and operations research offers a new dimension to the executive willing to investigate new approaches to old problems. Through such approaches a business will be able to adapt itself to changing conditions in a way most favorable to the business. This ability comes from using information as a management tool. Not only need we find an effective way to do today's job, but we must know how this way should be altered in the face of a constantly changing environment.

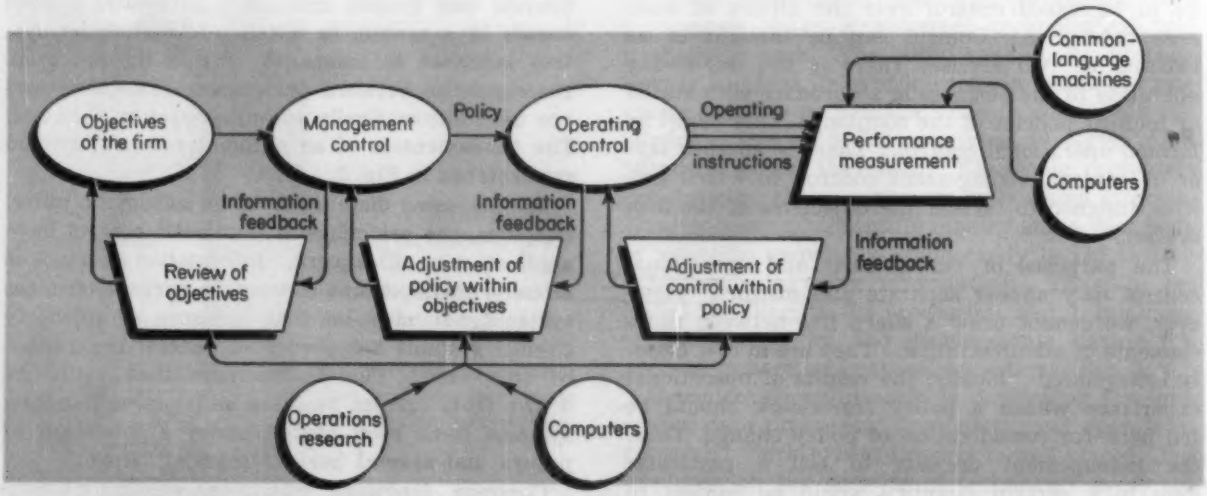

Fig. 3—Operational and management control shown in block diagram as separate but related functions. Note the interlocking feedback loops and the similarity of each loop to the diagram of the automatic control system.

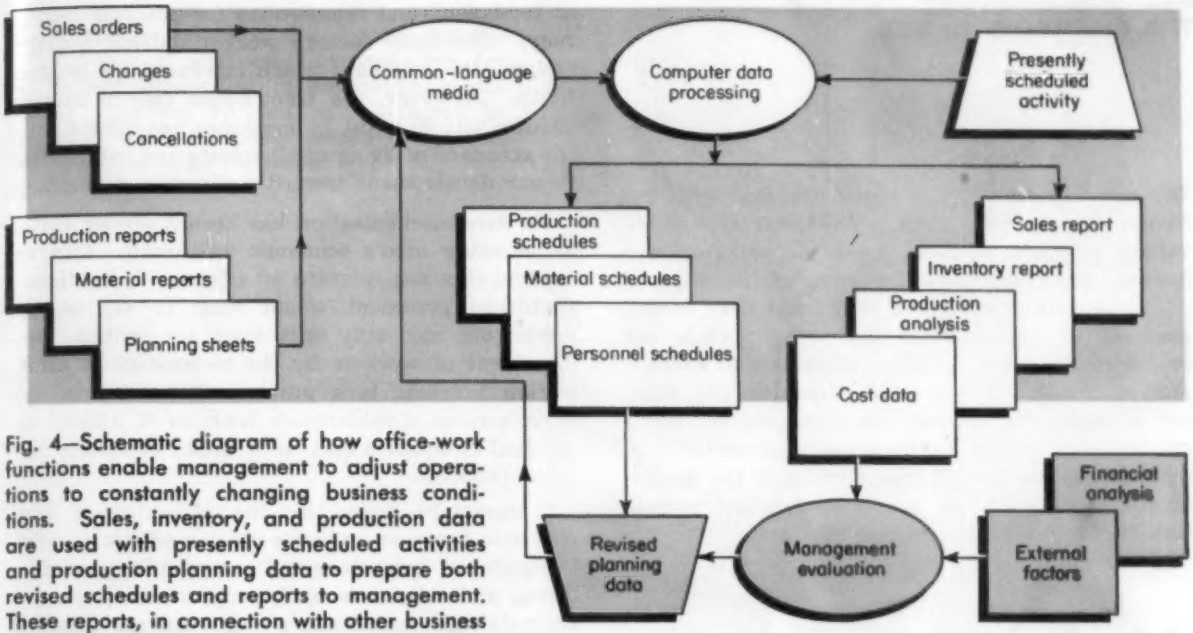

Fig. 4—Schematic diagram of how office-work functions enable management to adjust operations to constantly changing business conditions. Sales, inventory, and production data are used with presently scheduled activities and production planning data to prepare both revised schedules and reports to management. These reports, in connection with other business factors, then serve as a basis for readjusting production, material and personnel schedules.

The tools we have discussed permit evaluation of the effect changed conditions will have on business operations. In some cases these changes will represent an actual occurrence; in others, business will wish to test the effect of various possibilities before altering its pricing or operational structure.

The possibilities for evaluating the effect of changed conditions are endless. Either adjusting to reality or testing a proposal requires that business know the effect of change. The development of mathematical models and programming of computers to determine these effects are complex tasks, but they may be well worth doing. Both model construction and computer programming are investments in better information handling. Once this investment has been made, it is possible to test alternatives within the scope of the model with relative ease and economy. The potential uses for a combination of computers and operations research in determining the effect of changed conditions are many. Some possibilities follow:

1. Computation of how much wage and salary increases or changed working rules will cost the firm in a given period.
2. Determination of how changed material cost will affect product cost.
3. Application of rate changes against utility consumption patterns.
4. Projection of revised sales patterns against production schedules and inventory levels.
5. Determination of how changing prices for inventory items and altered conditions of purchase will affect optimum inventory levels.
6. Evaluation of changing transportation costs as they will affect material costs, and consideration of the combined transportation and price structure offered by alternate suppliers of material as means of reducing material cost.

Emphasis on evaluation of change through the use of models may have an important side effect. It concerns the frequent confusion of objectives with the means chosen to accomplish objectives. Once an objective is set, means to accomplish this objective are framed. The danger lies in regarding the means as objectives themselves and consequently losing sight of the objectives which brought these means into being. Perhaps an example will illustrate.

Periodic evaluation of employees is valuable to both worker and supervisor. It encourages discussion of good and bad aspects of job performance. Such discussions encourage continued development of promising employees and improvement or release of less satisfactory workers. Frequently, the matter of periodic wage increase is tied to satisfactory performance reports. In this kind of situation, we can draw a specific case of means becoming objectives in themselves.

A company required that employees be graded on a point scale and used the average number of points as a measure of employee performance. Then the condition was stipulated that a raise in salary is possible only if a certain point-average is reached. Supervisor recommendation for increased pay could be acted upon only in the light of this average. Thus a supervisor considering that an employee merits an increase in salary uses the rating system to document his decision. The impartial evaluation which would benefit both company and employee has become secondary. Somehow the objectives of impartial evaluation and

fair compensation have become confused with the means of achieving them. The arbitrary point-values assigned to such words as superior and average come to occupy the center of the stage.

A confusion of means with objectives is not confined to personnel rating scales. Objective evaluation of administrative situations is exceedingly difficult. Construction of models and their use in evaluating alternatives will focus attention on the separation of objectives and means. A realistic perspective of objectives and the means of accomplishing them will have extreme usefulness in forging better control systems.

Social and Economic Implications

We have discussed powerful tools by which business information may be initially recorded, processed, and put to use. These tools offer great potential for increasing management control and cutting information costs. If a reasonable proportion of these potentials is achieved, we can expect that administrative concepts and work patterns will have changed for many of the people employed by American business.

Automation is altering manufacturing techniques. Machines able to sense changes in a product being manufactured and able to respond automatically are taking their place in the factory. These automatic control devices combined with new production techniques are increasing the productivity of the factory worker. Many groups are concerned over the effects these developments may have on our labor force and economy. Many divergent viewpoints have been expressed on this topic.

In the office, too, we are witnessing the development of automatic control devices. Electronic computers are machines capable of recognizing changes in information patterns and assisting management in determining a favorable course in response to those changes, *Fig.* 4. Machines can do many office tasks for which people have so far been needed. Automation in the office is a definite part of the current trend in which the burdens of routine are lifted from men's backs and transferred to machines. This transfer is being viewed optimistically or pessimistically depending on the affiliation of the observer. No one, however, can deny that we are discussing an area of significant impact on the lives of the American worker.

Machines have rarely evoked enthusiastic response from people whose livelihood has been directly affected. The craftsman did not welcome the factory. Yet the establishment of the factory contributed to the present urban development, fall of feudalism, and foundations for political democracy. The early factory worker did not initially endorse the machines which increased his productivity. However, the tremendous rise in factory productivity brought by machines has helped raise the standard of living of all society and contributed to our development toward a classless democracy.

To date mechanization has been a strong factor in bettering man's economic well-being. Can we assume this happy state of affairs will continue? Historical precedent would seem to say so but precedents hold only until they are broken. Replacement of workers by the technology of information handling is a problem that deserves our most serious consideration both as it affects individual companies and as a broad economic and social problem.

It cannot be denied that the application of computers to business problems creates additional jobs. Designers of computers and components, manufacturing and sales personnel, programmers, systems analysts, and maintenance engineers are afforded employment by use of computers for business information processing. We can carry this point further by considering that computers, in helping to motivate this writing, created work for editors, typesetters, bookbinders, and (it is hoped) booksellers.

Electronic data processing holds the threat of replacement, however, for many clerical data processors. It must be recognized also that such victims of technological unemployment are usually not the ones for whom opportunities are broadened. The clerical workers dislocated by the use of computer techniques would not generally be qualified to contribute in fields where opportunities have been widened. Yet, while individual hardships occur, management planning and individual initiative can alleviate them.

It is the writer's conviction that application of new tools for office work will be a major factor in bettering the economic lot of all. These tools will enable business to stress its inherent advantages and work toward an optimum deployment of its physical and human assets.

More efficient utilization of business resources is a factor which makes the products of business endeavor available to more people. As this occurs, we can expect significant long-range changes in working and living patterns. The composition of the labor force in terms of clerks, factory workers, and professional employees, the relations between management and labor, the real value of wages, and the length of the work week with its implications on family living and cultural development will be strongly influenced by an unfolding pattern of automation. The further growth of automation is an inevitable consequence of our technological progress, but we should not forget that the best efforts of business, labor, and government will be needed to make that inevitability a force for the greatest good.

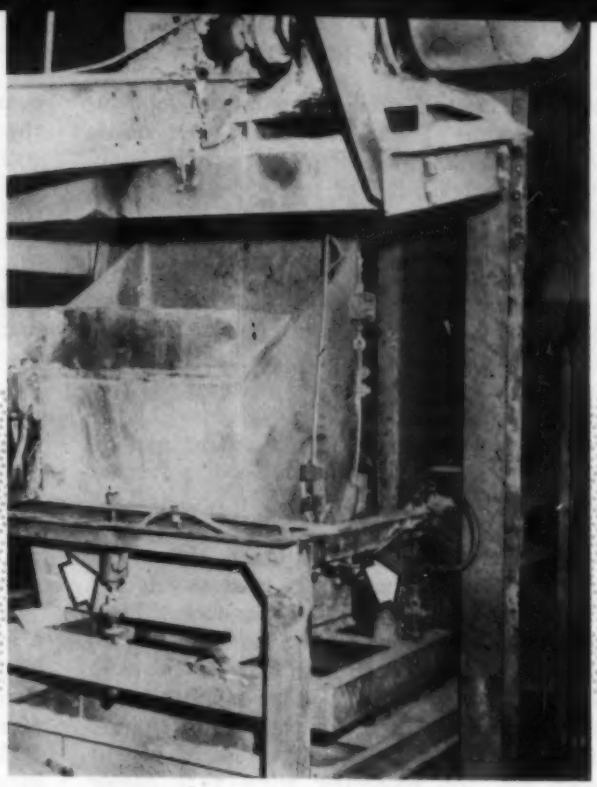

Fig. 1—Automatic proportioning of sands in a mixture for molds to make steel castings is controlled by weight in this foundry installation. Types of sand used are separately fed to the belt conveyor which empties into a skip bucket supported by load cells (indicated by arrows). When the preset weight is recorded, the controller stops the feeder.

AUTOMATIC BATCHING

PREPARES SAND FOR MOLDS

Repetitive blending of bulk materials in specified proportions is a problem common to many industries. This foundry has combined typical foundry equipment, weight sensitive load cells, a timer and a controller-recorder to speed up the preparation and improve the uniformity of sand mixtures for molds.

PROPORTIONING AND MULLING of mold sands, automatically, has been developed in the Granite City, Ill. plant of General Steel Castings Corp. The problem behind this development is that of accurately feeding water, binder and two or three types of sand into a muller (mixing mill); mulling them for a predetermined time to develop the sand characteristics required for high quality large steel castings; and accurately and consistently reproducing the specified mix in batches of 1400 to 2000 pounds in 2-minute cycles.

Considerable shortening of cycle time and increased utilization of muller capacity are obtained by feeding the desired quantities of sands and binders into a skip bucket while the previous charge is being mulled. Sands and binders are separately fed from storage bins by vibratory feeders and carried to the skip bucket by a conveyor belt. When the previous charge has been emptied from the muller, the water for the next batch is introduced into the muller and then the skip bucket is elevated and its contents dumped into the muller. The sand, binder and water mixture is mulled for the desired time and then discharged from the muller onto conveyor belts for distribution to various molding stations.

Weights of the different sands or binders to be used in a batch are determined by foundry experience and set by the operator. Separate dials on the control panel are adjustable for various

quantities of each of three sands in 20-pound increments. As the skip bucket comes to rest on its weighing platform, it closes a limit switch in an interlocking circuit designed to prevent the start of a filling cycle until the bucket is in place. The weighing platform is supported through spring elements and oak shear pins by three Baldwin-Lima-Hamilton SR-4 load cells used as tension members. The springs and shear pins protect the load cells against overloads. A combination controller and recorder is set to record the weight of the contents of the skip bucket as measured by the load cells. If the bucket retains more than 30 pounds of material when it is dumped, a further interlocking action also prevents the start of a new filling cycle.

When the filling cycle does start, the preset quantities of different sands are successively fed to the conveyor belt and into the skip bucket. First the vibratory feeder under sand bin *A* is started and operates until the desired weight of that sand is indicated in the controller. If the supply of sand in that bin is not sufficient for the desired charge, the filling cycle stops. When the desired weight has been fed, the controller stops that feeder and then similarly starts and stops the feeder under sand bin *B*. The feeder under bin *C* is likewise started and stopped automatically when sand *C* is used.

Binder is fed to the conveyor and then to the skip bucket by a vibratory feeder which loads a counterbalanced hopper. In setting up the process, the operator determines which of three binders will be used and adjusts the counterweight on the hopper arm so that the hopper will pivot downward, stop the feeder, and discharge its contents when the predetermined weight is reached.

A timer preset by the operator controls the muller cycle; including admission of water, dumping of the skip bucket, length of milling time, and opening and closing of the discharge door. After the skip bucket is dumped, it returns to its weighing platform and the sand proportioning process is automatically repeated. When the timer completes a cycle, it resets automatically and recycles. Once proper settings are made and the operation started, proportioning and mulling continue until the operation is stopped by the operator or a special control action.

Sand proportions in each batch are recorded on a strip chart and weight accuracy has been within 1 per cent for batches up to 2000 pounds regardless of moisture content, height of sand in the bins or cleanliness of the conveyor.

Use of this automatic installation has greatly increased the speed of production of mold sand and improved the accuracy with which batches are produced consistently. As can be seen, these worthwhile results were obtained by combining simple and standard components which have long been available. This technique can be applied with similar success in a great many industries.

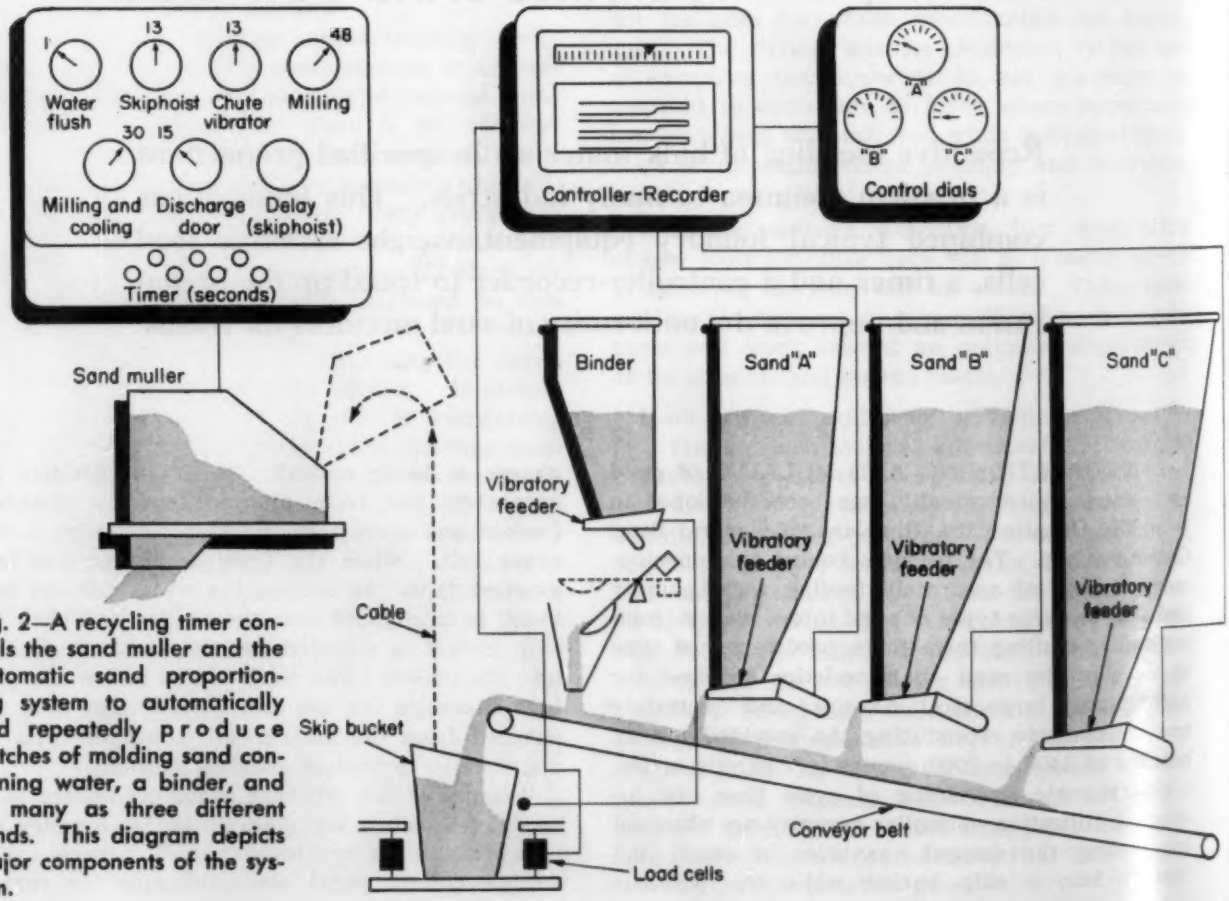

Fig. 2—A recycling timer controls the sand muller and the automatic sand proportioning system to automatically and repeatedly produce batches of molding sand containing water, a binder, and as many as three different sands. This diagram depicts major components of the system.

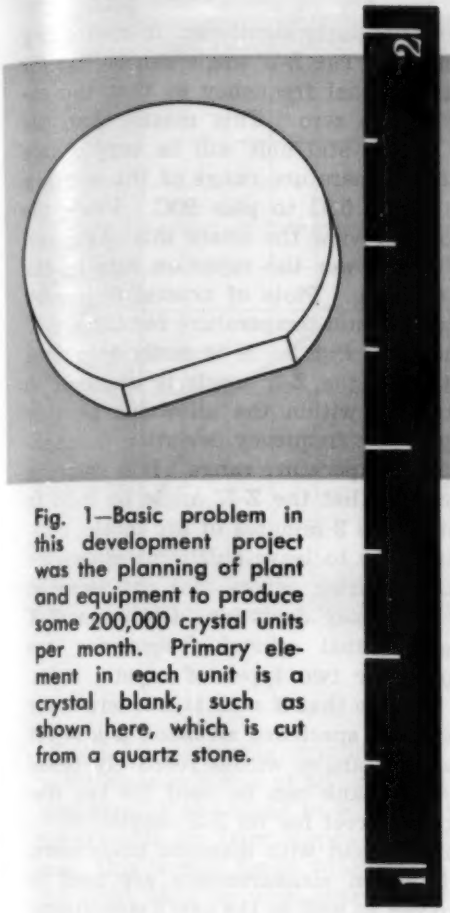

Fig. 1—Basic problem in this development project was the planning of plant and equipment to produce some 200,000 crystal units per month. Primary element in each unit is a crystal blank, such as shown here, which is cut from a quartz stone.

USING OPERATIONS RESEARCH IN

PROCESS PLANNING

FOR A NEW AUTOMATIC PLANT

Finding the optimum solution to a problem with many variables is a major benefit gained from the use of operations research (OR). This useful tool may be profitably applied in many different types of operations—sales, engineering, production control . . . An illustration of its use in planning production processes in a new plant is described here by a senior project engineer.

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PLANNING PRODUCTION PROCESSES and equipment is always an important undertaking. It is even more critical when the facilities being planned constitute an entirely new plant and individual production ideas and machines cannot be tried separately in an existing plant. Such is the condition under which Bulova Research & Development Laboratories Inc. has been developing means to produce large quantities of quartz crystal units for the Signal Corps (See—AUTOMATION, March 1956).

By a continual process of analysis and experimentation, individual machine developments are bound into an integrated plant unit with a balanced production capacity, guaranteed product quality, and the greatest possible reliability and ease of supervision. One of the analytical tools which has been of great value in our search for the optimum plant design is the technique called operations research or OR for short. Operations research is a mathematical approach to industrial engineering, and its particular strength is in finding the optimum solution to a problem with many variables. We have used minimum cost as our criterion in most of our analyses to date and have included such factors as cost of development and fabrication, and operations costs such as direct and indirect labor and maintenance.

In each analysis, we were looking for the machine that would give us the minimum total cost considering all of the foregoing factors, and using five years as the amortization period for all fixed costs. We have been getting some extremely useful and often surprising results from our analyses. The reason for this is that an experienced estimator can produce a detailed breakdown of costs with reasonable accuracy; but no person can intuitively combine all of the variables correctly in such a complex situation. Therefore, the best intuitive guess will very often be wide of the mark. Mathematical analysis finds the optimum combination of the detailed data with high reliability, and its value is only limited by the accuracy with which the estimator figured the detailed costs. An exam-

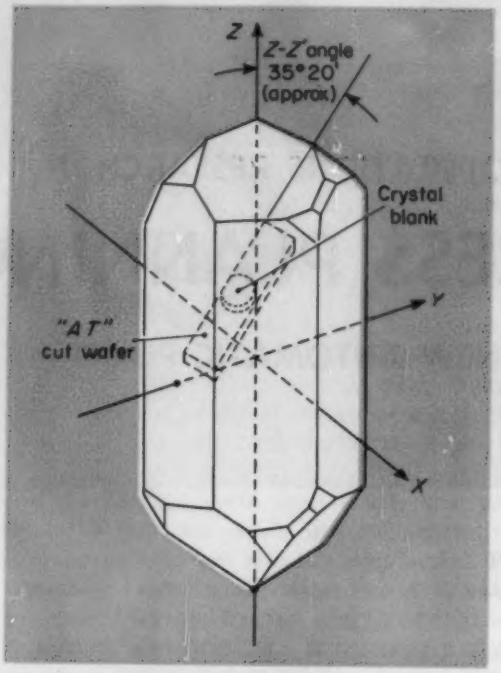

Fig. 2—Stones used as raw material have natural crystal axes. The crystal blank must be cut from the stone with accurate orientation to these axes to obtain the required characteristics in the completed crystal unit. The Z-Z′ angle is especially critical in temperature-frequency characteristics.

ple of this type of analysis may indicate the power in the methods used.

A Specific Problem

Crystal blanks, *Fig.* 1, for quartz crystal units are cut from quartz stones. The angles at which the crystal blank is cut with respect to the natural crystal axes, *Fig.* 2, control the temperature coefficient of frequency of the crystal unit. The Z-Z′ angle is particularly significant in controlling this characteristic. The Z-Z′ angle can be cut for any particular nominal frequency so that the coefficient is close to zero. This means that the frequency of the crystal unit will be very stable throughout the temperature range of the military specification, minus 55C to plus 90C. From the production point of view the closer this angle can be controlled, the lower the rejection rate in the temperature test run. Plots of crystal frequency deviation versus crystal temperature for three Z-Z′ angles are shown in *Fig.* 3. It is easily seen that accurate control of the Z-Z′ angle is required to hold the frequency within the allowable plus or minus 0.005 per cent frequency deviation throughout the specified temperature range. It is common practice to require that the Z-Z′ angle be held to within plus or minus 3 minutes of arc of the optimum angle, in order to leave sufficient allowance for other manufacturing errors that eat away at the allowable frequency deviation. Optimium Z-Z′ angles versus nominal crystal frequencies are shown in *Fig.* 4 for two types of crystal units. These curves indicate that if a plant's orders cover the whole frequency spectrum, no blank is a reject because of its Z-Z′ angle, within relatively broad range, since each blank can be used for the frequency which is correct for its Z-Z′ angle.

The Z-Z′ angle is cut with diamond blade saws, and x-ray diffraction measurements are used to control the process as well as the saw's consistency permits. Until the advent of the Hoffman wafering saw the control of the Z-Z′ angle was very poor. In fact, the spread of Z-Z′ angle over a batch of crystals might average 15 minutes of arc. A few companies cut slowly in an attempt to improve the accuracy of the saw, but most companies cut rapidly, and then correct each blank individually. With either procedure, however, an x-ray machine is always used to sort the individual blanks according to Z-Z′ angle. Correction is commonly accom-

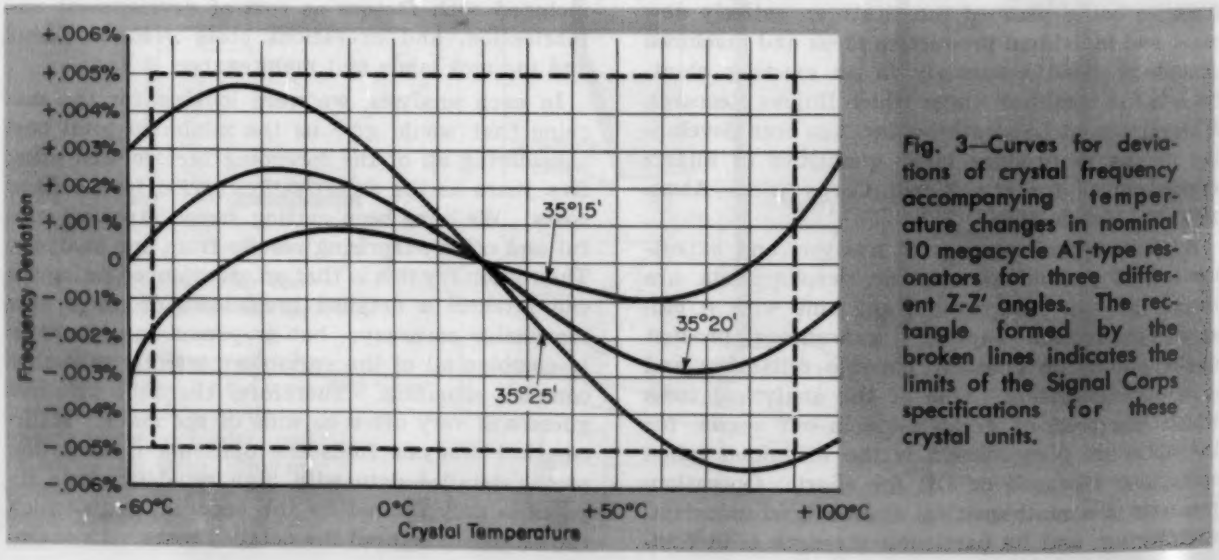

Fig. 3—Curves for deviations of crystal frequency accompanying temperature changes in nominal 10 megacycle AT-type resonators for three different Z-Z′ angles. The rectangle formed by the broken lines indicates the limits of the Signal Corps specifications for these crystal units.

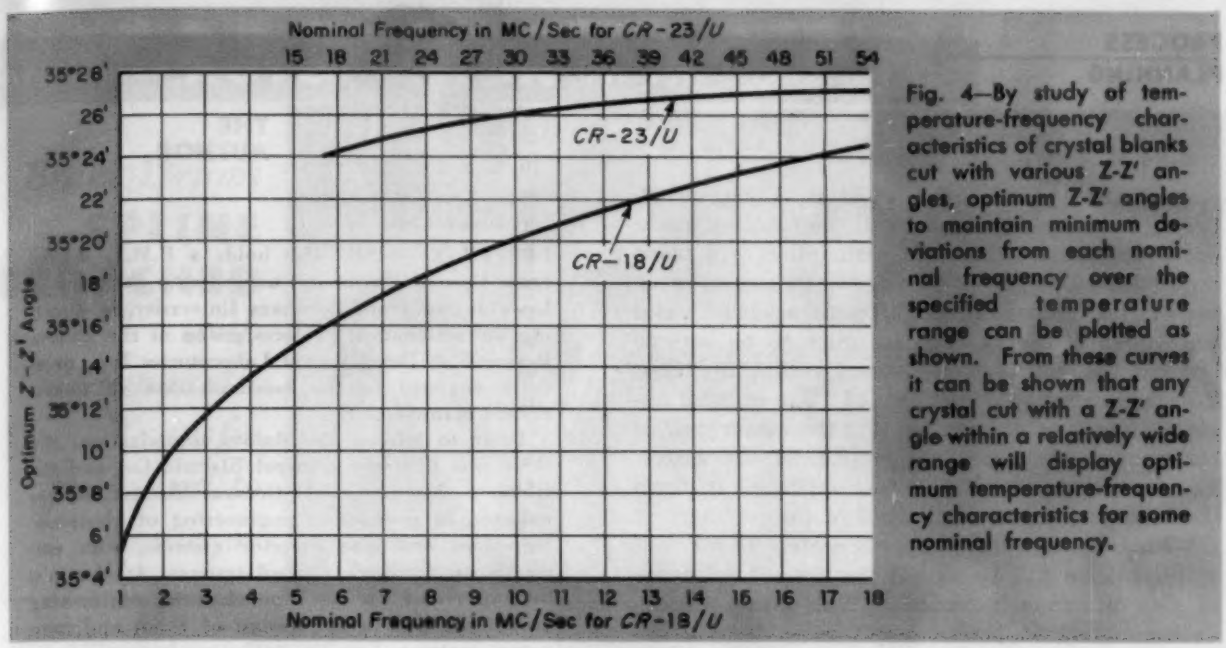

Fig. 4—By study of temperature-frequency characteristics of crystal blanks cut with various Z-Z′ angles, optimum Z-Z′ angles to maintain minimum deviations from each nominal frequency over the specified temperature range can be plotted as shown. From these curves it can be shown that any crystal cut with a Z-Z′ angle within a relatively wide range will display optimum temperature-frequency characteristics for some nominal frequency.

plished by purposely grinding the face opposite to the measured face at an angle of twice the error, thus causing the blank to be wedge-shaped. When the crystals are later lapped to the required thickness, this wedge tends to average out, and thus the blank ends up with approximately the desired Z-Z′ angle.

The Hoffman saw has substantially greater accuracy as well as a higher production rate than the saws commonly used in this industry. The suggestion was raised that very likely angle correction on individual blanks would no longer be required, and even more radically, perhaps the x-ray sorting machine would no longer be required. In an existing plant this could be done by simply trying to make crystals without correction or sorting. This direct method is often not practical of course, and in our case the plant wasn't even in existence. We had to know the answers *before* the money was invested in design of equipment.

▸ Application of OR

The systems group undertook to answer these questions. As little detailed information was available on the accuracy of the Hoffman saw, an experimental program was required before any analysis could be made. It is essential for two reasons that the operations analyst begin his work at this time, and not wait till the experimental data are available. First, only by planning the experiments will he be sure of getting the information he needs, in the form that he needs it. Second, by applying his knowledge of statistical methods, he can considerably shorten the experimental program by requiring less data than an engineer untrained in statistics would realize. In fact, experiment planning is an important field for operations analysis.

Our operations analyst, after having been fully briefed on the problem at hand, restated the problem in definite terms and planned a set of experiments in cooperation with the engineers involved. The problem was stated as follows:

1. What percentage of blanks will fall within plus or minus 3 minutes of the desired angle after lapping if no x-ray measurements are made on the blanks after wafering on the Hoffman saw, and if no angle correction is used?

2. What percentage of blanks will fall within plus or minus 3 minutes of the desired angle after lapping if an x-ray sorter (with a known precision) is used to sort the blanks into groups with 2-minute ranges before lapping?

3. Which method is the more economical for the plant as a whole?

A series of experiments was conducted in cooperation with the Frequency Control Branch of of the Signal Corps Engineering Laboratories at Ft. Monmouth, N. J., where a Hoffman saw was available. The experiments were actually run to solve several other plant problems connected with wafering aside from the problem concerning angle correction and x-ray sorting. Basic knowledge of the wafer quality as the wafers were received from the Hoffman saw was obtained from this experimentation.

Exact statistical information was then available on the spread of Z-Z′ angle in a large sample of blanks, and on the "wedginess" of the blanks. This wedginess was higher than expected, though no doubt less than on earlier saws, and this led to an extra complication in the problem. It was found that the two sides of a blank would differ in Z-Z′ angle by 1.5 minutes, on the average, but since the x-ray sorter only measures one side, the other side remains unknown. Also, an assumption had to be made as to what final angle the sides of a wedge-

shaped blank would arrive at after lapping. Following industry experience with the wedging method of angle-correcting, the assumption was made that the final angle would fall somewhere between the original sides. Three different assumed cases were used in the analysis in order to be sure to bracket the actual facts—namely, that the final Z-Z′ angle would fall within: (1) The original angle contained by the wedge, (2) the center half of the wedge, (3) the center quarter of the wedge. The foregoing information was sufficient to form the basis of a rigorous analysis of the problem.

Without x-ray sorting, approximately 78 per cent of the blanks will be within the desired tolerance of plus or minus 3 minutes. With x-ray sorting, approximately 94 per cent will be within the desired tolerance. Thus, it can be expected that x-ray sorting will increase the plant yield by over 10 per cent. Calculations based on this information showed that the development of an x-ray sorter would pay for itself in less than six months, and that, though the Hoffman saw was indeed a substantial improvement over earlier models, an x-ray check on the individual blanks would still be required. Thus, the application of operations research gave a definitive and a practical answer to an important but complex plant design problem.

Other OR Uses

The problem just mentioned is of course only one of the many that have been investigated during the life of the program. Some others are:

1. Finding the optimum combination of sawing and lapping—in general the slower the sawing, the better the blank quality, and the less lapping is required since thinner blanks can be sawed.

2. Setting of tolerance limits throughout the plant—will be based first on guarantee of crystal unit quality and then on economy of plant operation.

3. Problems of machine capacity, inventory and storage for work in process—have been and will continue to be the subject for operational analysis. That this problem is considerable is easily seen when it is realized that it is typical in this industry to have 50 per cent of the blanks rejected after they are diced.

The entire problem of quality control and production control will require considerable analysis before design work can be initiated on actual equipment. At present, a central quality control and production control area is visualized to which information required for process control will flow from throughout the plant. Some of the data will be from inspection stations and some will be from process machines themselves. A console is envisioned where the information will be assimilated, and from that point instructions can flow outward for the adjustment and control of the various processes for maximum plant efficiency. With a centralized control center, combinations of processes can be controlled rather than each process being controlled singly. For example, if the average value of some crystal characteristic at Process *U* is rising and yet is still within tolerance, it may be possible to increase plant yield by making a slight adjustment at Process *W* or *X* or *Y*. Such rapid, coordinated control means that individual process tolerances can be broadened. This means in turn increased yield, higher plant capacity and lower crystal cost. As the overall control problem has not yet been attacked, the complexity of equipment required for such an operation is not yet known; but in a plant where a single line is turning out 10,000 units a day, and where there are likely to be 100,000 blanks in process at all times, the most careful analysis is justified.

No operations analyst claims that his answers are final. The analyses are of course limited by the accuracy of the input data supplied. Also, there are many factors that cannot be put in terms of dollars and cents or other definitive numbers, and thus they do not appear in the analysis directly. Therefore, at the end of an operations analysis, an executive decision is required. But data such as can be supplied by an operations analysis can make that decision the difference between a guess based on intuition and a firm judgment which makes the most of all the experience and background of the person making the decision. It is important to emphasize that these analyses are not a matter of idle curiosity on our part as to how the plant will turn out a few years hence. This work will aid in arriving at the best machine for each task, and will make possible an integrated production line with a minimum of changes at the pilot run stage.

THE AUTHOR

LESTER V. WISE, who holds a B.M.E. degree from Cornell University, as well as a Bachelor of Laws degree from Fordham University, is directing an automation projects group at the Bulova Research & Development Laboratories Inc., presently engaged in the mechanization of quartz crystal manufacture.

Prior to joining the Bulova organization, Mr. Wise was with the General Electric Co. and the Glenn L. Martin Co. At General Electric, he was engaged in production engineering of electronic torpedoes and gun director systems, with emphasis on feedback control systems. At Martin's, he supervised on electromechanical engineering group engaged in the design of servo and computer systems for an anti-aircraft system, including an automatic target projection system for the simultaneous control of as many as 32 targets

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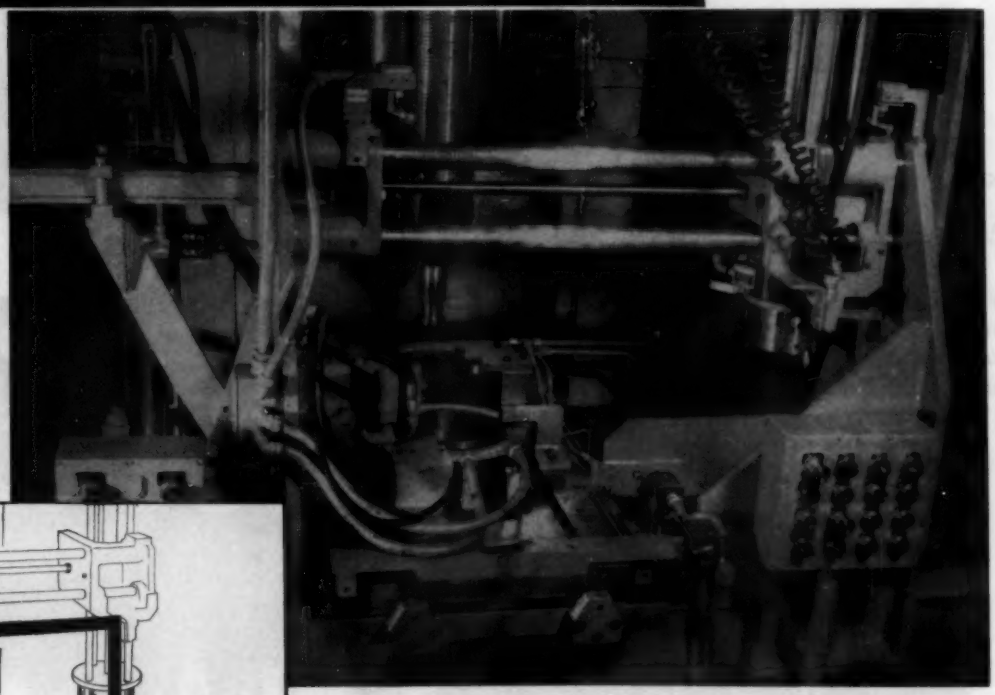

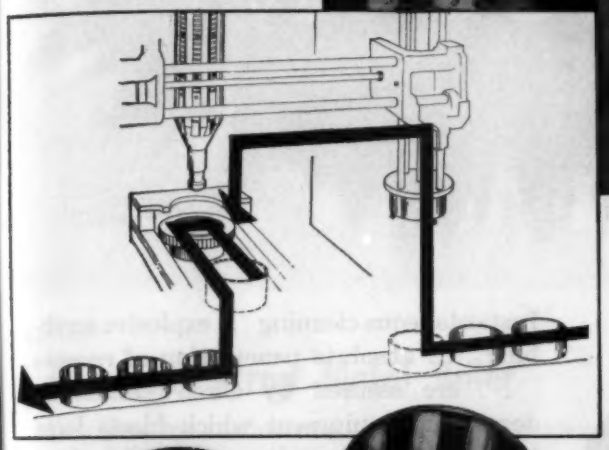

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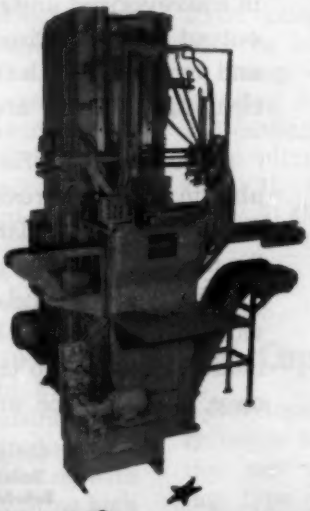

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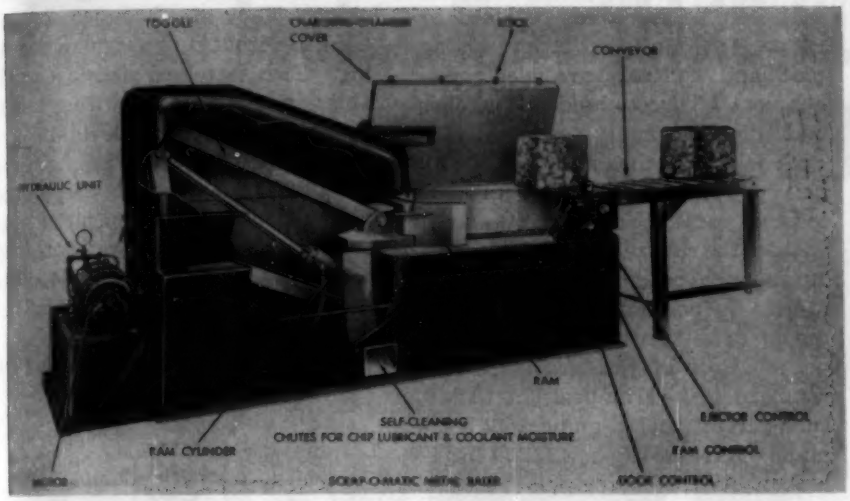

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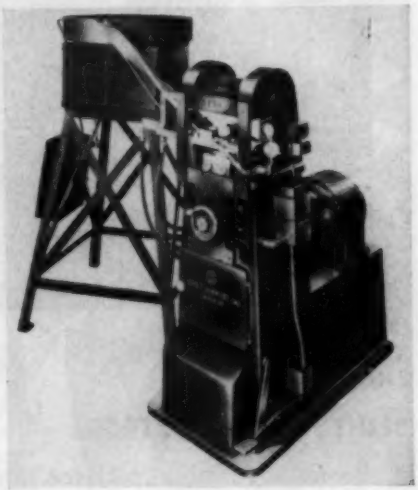
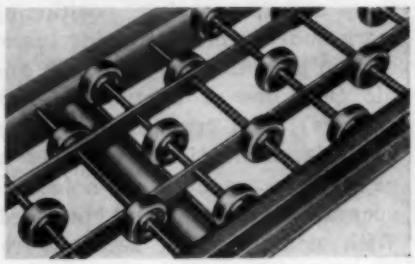
End Cap Marker

Developed to stamp automatically motor end caps with identification, new machine features vibrating type hopper for feeding of parts. Orientation is accomplished by means of fingers with a final 180 degree turn in the chute leading to the machine. Parts are dumped into the 36-inch diameter hopper which is large enough for a 30-minute run. Marking rate is 1600 pieces per hour. Marking tool which mounts in the machine head consists of a radial type and logotype holder to permit variations in marking, thus providing the flexibility required. Several holders are used with sufficient type and logotype, allowing setups for subsequent runs to be made while machine is in operation. **Geo. T. Schmidt Inc.**, 4108 Ravenswood Ave., Chicago 13, Ill.



Circle No. 2 on Reply Card



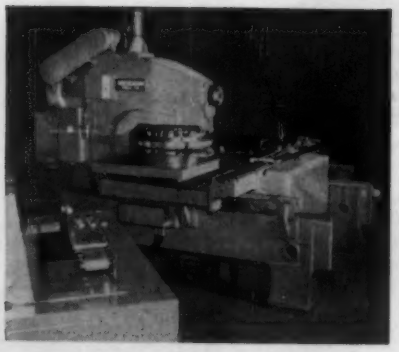
No. 3—

Galvanized Conveyors

Well suited to outdoor operations and in moist areas such as cold storage rooms, food process-

ing plants and warehouses where cold causes water condensation, line of gravity conveyors is completely galvanized. Conveyors are available in the wheel conveyor line in widths from 12 to 24 inches. Galvanized steel used is produced by Inland Steel patented new process which assures perfect bond (no flaking off) and uniform thickness of galvanized coats. **Rapids-Standard Co. Inc.,** 342 Rapistan Bldg., Grand Rapids 2, Mich.

Circle No. **3** *on Reply Card*

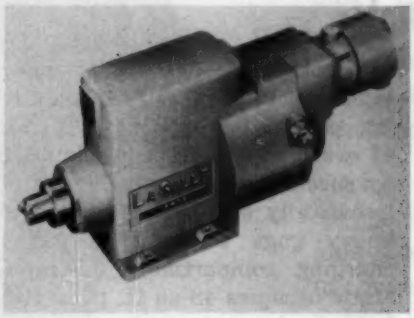


No. 4—

Turret Punch Press

Complicated hole patterns, including openings of many sizes and shapes are located and punched in large steel sheets by turret punch press. Automatic controls on unit cut piercing time, eliminate fatigue factor and assure uniform accuracy. Illustrated model has punching capacity of 40 tons and throat depth of 33 inches. Press and work locating table are controlled by a tape fed, electromechanical programming unit to perform all functions automatically — simultaneously positioning work under punch; selecting turret station carrying proper punch and die (any one of 20 up to 6-inch squares); and tripping the press. Cycle is automatically repeated in rapid sequence until all holes are accurately located and punched. With new machine, setup is reduced to placing desired tape in the programmer and loading the material onto the table. Material is positioned by the operator to mechanical zeroing stops and clamped in position in seconds. Special vinyl tape which is not affected by shop oils or grease eliminates need for shop drawings, templates or manual layout of each hole location. Complete job is punched on the tape and, once prepared, tape becomes the template for the job, and can be used and then filed for subsequent use. Location or size of any hole may be changed simply by covering that section of the tape with a gummed sticker, and punching the new information. Any section of the tape can be removed, replaced or covered. Entire programming unit and controls are electromechanical. Turrets hold all punches and dies normally required for each job. Punches and dies of any size or shape, including groups, louvers and knockouts can be used within the capacity of the press. Any punch or die is brought into piercing position automatically during the work locating cycle without loss of time, and the turrets are locked in position to assure perfect tool alignment. **Wiedemann Machine Co.,** 4272 Wissahickon Ave., Philadelphia 32, Pa.

Circle No. **4** *on Reply Card*

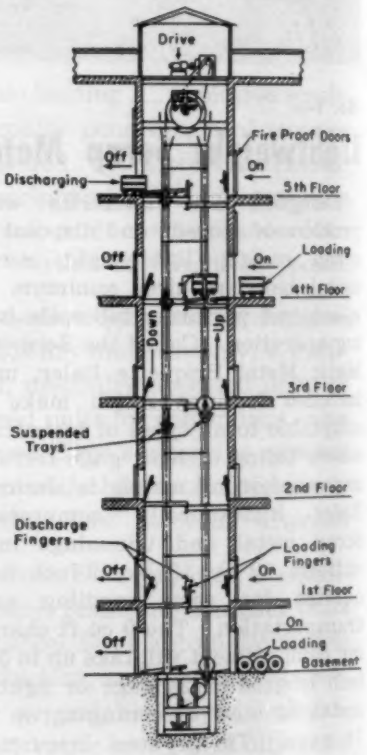


No. 5—

Automatic Power Wrench

Two-speed power wrench with controlled torque is synchronized with the machine cycle to give automatic engaging and disengaging of parts. Unit is used on boring mills, grinders, lathes, multiple drilling machines, pipe threading machines, screw machines, thread machines, etc. Self-contained power wrench is automatically lubricated and operates with high speed, low torque approach; low speed, high torque clamping; and high speed, low torque return. It features a fluid motor drive with a sight gage to indicate the fluid level. The fluid motor drive enables clamping light parts, or parts with thin-walled areas without the danger of fracturing the parts. Controlled positive clamping practically eliminates breakage of cutting tools and the resultant shutdowns. Standard operations, such as loading, work cycle, gaging, indexing and unloading are performed automatically and are repeated in a short time interval. Power wrenches are designed to fit any standard or special machine. They are designed for vertical, horizontal or angular mounting. Two standard sizes are available: a small model, with a torque capacity from 0 to 800 in.-lb; and a large model with a torque range from 800 to 5000 in.-lb. Hydraulic power package with positive controls is provided to regulate and control the power wrench. **LaSalle Tool Inc.,** 3840 East Outer Dr., Detroit 34, Mich.

Circle No. **5** *on Reply Card*



No. 6—

Interfloor Conveyor

Tray-type conveyor automatically loads, transfers and delivers heavy loads between as many as six floors. Designed for use in warehouses, textile mills and other installations where long interfloor transfer hauls of heavy loads pre-

(Advertisement)

SET SCREW & Mfg. Co.
BARTLETT, ILL.
(CHICAGO SUBURB)

Set Screw News
& Mfg Co

WE SPECIALIZE IN SOLVING PUZZLING SET SCREW PROBLEMS

Issue No. 2A | AUTOMATION EDITION | EXTRA!

Parts Maker Speeds Set Screw Application 7 Times Faster, New SETKO HOPPER-FED Way

Free Demonstration at Set Screw Plant Enthuses Hundreds

Manufacturers of a wide variety of products are welcoming Hopper-Fed Headless Set Screws as the solution to speeding up set screw applications. Only a few months after their announcement, the special units used with Hopper-Fed Setko Headless Set Screws have already been widely ordered, and put into highly successful operation. These machines can be adapted to any machine of your choice.

- One Chicago parts manufacturer who applies set screws into plastics found that this equipment stepped up his production rate from 300 per hour . . . to 2000 per hour.
- Officials of a world-famous bearings manufacturing plant flew to the Setko plant to watch our demonstration and bought two sizes of the units almost instantly.
- Others who have already ordered include a pulley manufacturer . . . a Detroit motor drive maker . . . a fan-plate manufacturer.

Hundreds Watch Spectacular Demonstrations

Many manufacturers are accepting our invitation to witness, without any obligation, demonstrations of the hopper-fed set screw application at the Setko plant. They see a machine occupying about 1 sq. ft. floor space automatically rejecting misfits and feeding precision-perfect set screws mechanically from a vibrating hopper to a tube, through which they slide single-file, heads up, to arrive correctly positioned at the job, ready for driving. (See illustration.)

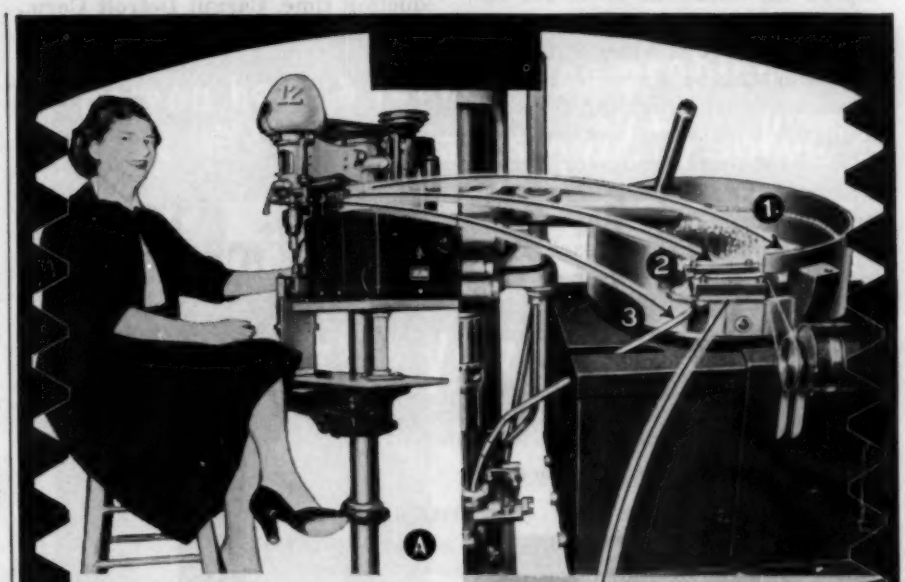
Industrial Magazines Enthuse over Advantages

Machinery and production magazine articles are featuring the many advantages of the hopper-fed headless set screw method . . . such as . . .

- Requires 1/5 to 1/10 the time of former methods.
- Works equally well with all metals and with plastics.
- Can be used for practically any headless set screw application, including the new Setko Self-Tapping.
- Reduces to minimum such problems as floor loss and cross-threading.
- Makes possible faster delivery.
- Permits smaller set-screw inventory.

Attend one of these "hopper-fed" demonstrations at our plant, at your convenience. Write, phone or wire when you would like to come. Easier still . . . Check the demonstration request on the Coupon.

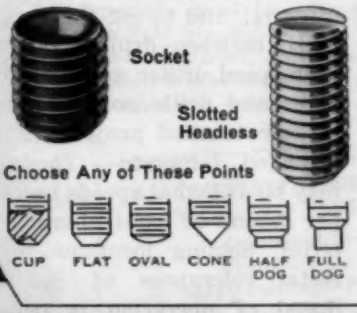
FILL OUT AND MAIL THIS TODAY ➡



(A) Complete mechanism,* consisting of (1) vibrating hopper, (2) roller device that puts all the set screws "right-side-up" and (3) tube that feeds the set screws to the job, correctly positioned for driving.

(B) Close up view of tapered roller device "lining up" the screws—an exclusive Setko feature. (Pat. Pending)

Available in Either of these Popular Styles and with any Type Point



We Specialize in Solving Puzzling Set Screw Problems *by originating new developments such as these (Pat. Pending):*

Zip-Grip Self-Locking
Nu-Cup (increased holding power)
Fluted Self-Tapping
Self-Tapping Slotted Set and Fastening Screws
Pivot-Lok (for double screw applications)
Super-Tork, Safe-Tork and many others

Check Coupon for Bulletins or Complete Catalog

*Pat. No. 2,636,945

1048R

COUPON

SET SCREW & MFG. CO. 266 Main St., Bartlett, Illinois

☐ I would like to have a demonstration at your plant in Bartlett, Illinois (Chicago suburb) of the special operating mechanism for the new Setko Hopper-Fed Headless Set Screws. Please advise me how this can be arranged without any cost or obligation on my part.

☐ Please send bulletins on these other screws.....

☐ Please send complete catalog.....

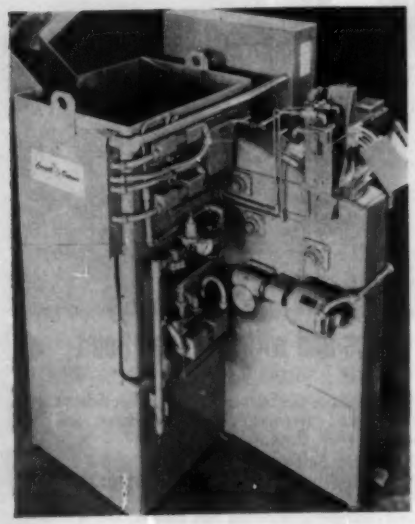
INDIV. NAME..... POSITION.....

COMPANY .....

ADDRESS..... CITY..... ZONE ..... STATE.....

sent serious handling and cost problems, automatic system consists of: Tray type elevator conveyor with trays spaced 25 ft apart between two parallel roller chains; loading and unloading entrances at each floor on opposite sides of the conveyor shaft; safety fire doors, side-sliding or up-sliding, at each entrance; automatic loading and unloading fingers at each station; and a complete set of operating and safety controls. Trays move at a speed of 45 fpm, driven by hydraulic-electric unit housed at the top of the shaft. In order for the conveyor to operate, only one door on the load side and one on the unload side may be open. Pushbutton stations at each operating floor are equipped with start buttons, red pilot light and indicator lights showing the position of unload fingers at each floor. An emergency safe run switch at each floor can stop the entire transfer sequence at any point. Limit switches are installed on doors at each loading point and on loading fingers to insure exact loading and smooth transfer sequence. **Gifford-Wood Co., Hudson, N. Y.**

Circle No. 6 on Reply Card

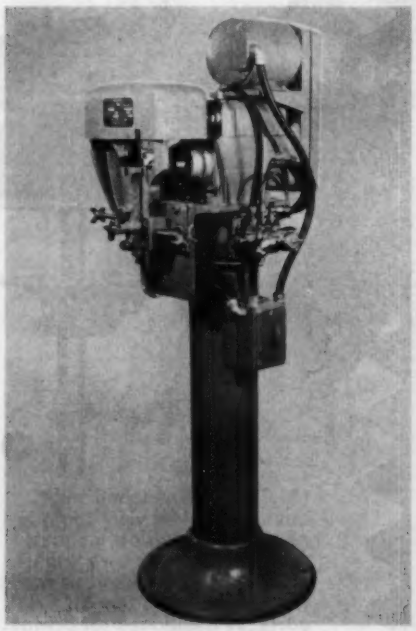


No. 7—

Hopper Feeder

Parts such as gear blanks, bearing races, pistons, many screw machine products, etc., are received at any rate—in bulk, with random orientation—and then discharged —orientated and aligned—for the following machine at any position and on demand of the machine, by new hopper feeder. Where desired, the unit can be equipped with a conveyor system which will elevate parts up to 15 ft and deliver overhead to a machine as far away as 50 ft. Also, hopper feeder can be equipped with a gage to reject parts that do not meet specified tolerance. Usual usage of the feeder is at the head of a line, although unit is equally feasible for a single machine. Under production conditions, hopper feeder serves as unfinished storage, eliminates manual handling, keeps parts cleaner, conserves floor space, and cuts production time. **Cargill Detroit Corp., Birmingham, Mich.**

Circle No. 7 on Reply Card

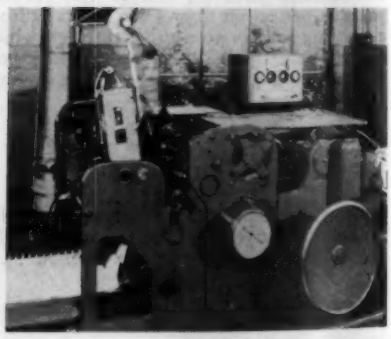


No. 8—

High-Speed Driller

Designed to utilize the proper feeds and speeds in drilling through material, and to cut the long time-lapse between drilling operations, high-speed driller automatically locates and drills holes in response to saw toothed projections on an attached template. These holes may be drilled at speeds up to three per second in 0.064 aluminum material, holding locations to sheet metal tolerances of $\pm$0.01-inch. Speed of operation is dependent upon hole spacing, diameter, depth and the type of material being processed. Tooling required for the operation of the pedestal mounted machine consists primarily of a sheet of template stock, cut to extend ¼-inch beyond the face of the material to be drilled. Overlapping edge is notched so that the front edge of each tooth is directly over the center line of the hole to be drilled. Locators and clamps are employed to position the part on the template. Both template and part are fed across the machine, with the flange of the part fitting into an adjustable slot on the front of the driller. The toe of the flanges rides on an adjustable stop which is preset to the required distance from flange toe to center line of hole. During the drilling operation, full support of the flange is obtained by adjusting a vertical guide to suit the length of the flange. When the part and template are fed into the driller, the template's teeth engage a trigger mechanism, forcing it against a dead stop. This mechanism actuates the machine, automatically drilling a hole directly in front of the face of the template tooth. When the drill reaches the fully retracted position, the trigger assembly automatically releases the template, allowing template and part to be moved forward to the next tooth for repetition of the cycle. Driller is especially adapted to drilling parts having a high number of holes with relatively close spacing. **Fairchild Aircraft Div., Fairchild Engine & Airplane Corp., Hagerstown, Md.**

Circle No. 8 on Reply Card



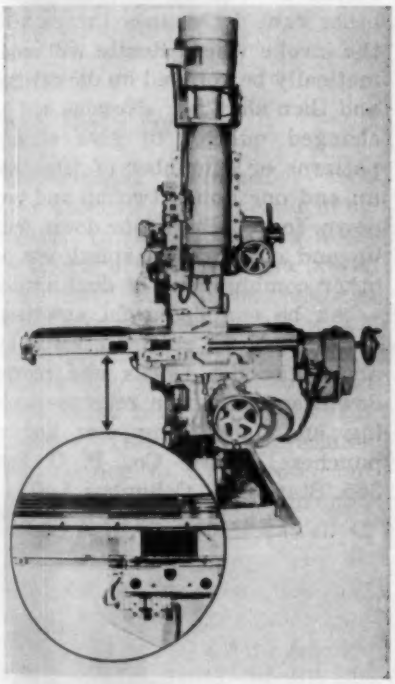
No. 9—

Counter & Tape Inserter

Accurate tabbing of many stream fed production items is afforded by solenoid actuated tape inserter. Typical applications include use with envelope, box, printing and other machinery. Inserter operates in conjunction with preset electronic counter. Tape

inserter is operated on the solenoid principle and is actuated by preset counter when the desired count is reached. Counter can be set at any count from 1 to 100. Tape in any length from 1 to 6 inches can be slipped between production items to facilitate rapid visual count and to help packaging operations. Electronic counter accurately registers number of units as they break the photolight beam, and any quantity can be selected within range of the specific counter used. Illustrated model is shown in use with Beasley & French machine; inserter is slipping marker tape behind every 25th finished envelope automatically, eliminating hand operation of counting and inserting count tapes. **Post Machinery Co.**, Electronic Products Div., 155 Elliott St., Beverly, Mass.

Circle No. **9** *on Reply Card*



No. 10—

Position Control

Milling machines can be converted for precise jig boring operations by application of positioning control system, called Inductosyn®. Illustrated system provides for control of *X* and *Y* axes by elements shown mounted along the table and cross slides of the miller. Elements are electronically actuated by a pushbutton keyboard input control for *X* and *Y* positioning with a program drum providing for automatic operation of 15 positions. System consists of precisely spaced metallic conductors on glass plates, comprising circuit elements, a scale which is attached to a stationary part of the machine, and a slider carried by the moving part. Because these elements are mounted directly on the machine, errors due to lead screws, rack and pinions, or gear trains are eliminated. Measurements are referenced to an established zero reference, also eliminating accumulative errors. Work performed on this machine consists of automatic sequential operations comprising boring and reaming of precisely located holes. Although in illustrated application, a keyboard and program drum input control is used, operation from punched cards, punched tape, magnetic tape, etc. can be provided. Control can be applied to any number of linear and rotary axes and programmed for either simultaneous or sequential operations. System can be applied to drill presses, boring machines, milling machines, grinders,

do you have a lubrication problem that oils and greases fail to solve?

META-FILM

will solve your problem!

IT'S A SOLID LUBRICANT

Forms a tough, unbroken film over any metal without affecting precision tolerances, to reduce friction offered by the metal, and in turn, to increase the wearlife.

IT WORKS ON ANY AND ALL METALS

Iron—Steel—Stainless Steel—Aluminum—Stellite—Titanium Chrome—Nickel—Tin—Cadmium and Other Plating—Brass Bronze—Copper Alloy—and all Special Heat-Treat alloys.

IT WORKS WHERE OTHER LUBRICANTS FAIL

It lubricates at extreme temperature and pressure ranges; sealed and inaccessible bearings or assemblies; bearings adjacent to any surface that cannot be contaminated; mechanisms that operate intermittently over long periods; parts where the environment would affect average organic lubricants; and parts where dust and solvents present problems. Especially good for intricate electronic switches, instruments and light tripping devices. It's excellent for all high-friction, fast-moving parts; it cuts operating expense, service calls and repairs; it prevents galling and seizing; and it permits rapid assembly and dismantling.

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American Metaseal of Detroit

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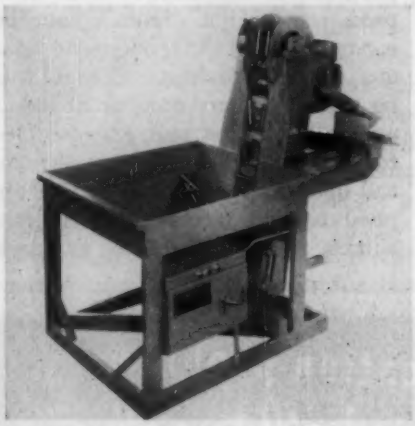
jig borers, gear cutters and lathes. **Farrand Controls Inc.,** 4401 Bronx Blvd., New York 70, N. Y.

Circle No. **10** *on Reply Card*



No. 11—

Bar Feed Hopper

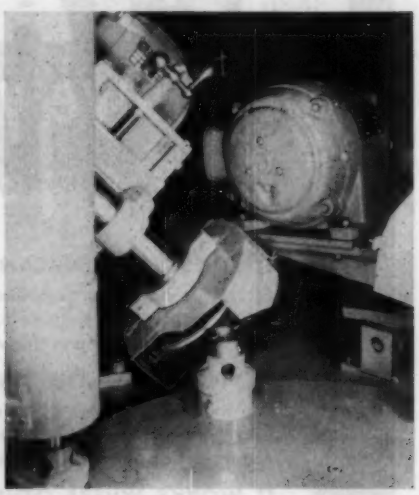
Bar shapes are automatically oriented and fed from the large storage bin of new automatic feed hopper to furnaces, presses, secondary operations and washing machines at production rates as high as 1000 bars per hour. Controlled flow of oriented parts is automatically fed to processing equipment without operator assistance. Illustrated hopper feeds 1¾-inch diameter by 8 inch long heavy wall tubes to a finish machining line at the rate of 360 tubes per hour. Storage bin holds enough tubes for 8 hours of continuous production. These tubes are delivered from the storage bin to the short feed tray at the right of the machine. Flow of tubes from the storage bin is controlled electrically by the number of tubes at the feed tray. The processing machines are fed directly from the feed tray. Dimensions of hopper are: 4 ft. 6 inches wide by 8 ft. 9 inches long, by 8 ft. 4 inches high. **Campbell Machines Co.,** 18634 Fitzpatrick, Detroit 28, Mich.

Circle No. **11** *on Reply Card*

No. 12—

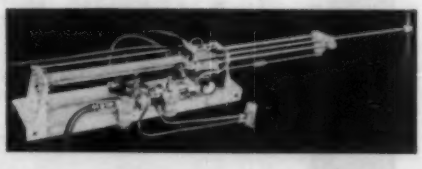
Deburring Machine

Two hundred multislotted, broached parts are deburred per hour by new automated machine. Unit uses five Fullanchor brushes, which are wheel brushes made by driving a heavy wire staple through a round steel channel to anchor each tuft individually. Crimped steel wire brushes are 8 inches in diameter and revolve at approximately 3000 r.p.m. Their penetration of the work is approximately 0.060. Brushes can be adjusted to compensate for wear by turning hand wheels on each brush station individually. Each brush is driven by a 1 hp. motor. In operation, an operator places the gear or part on an expanding collet which holds it in place while it moves around an automatic indexing table. Part travels through five brushing stations and is indexed into four different positions, thus presenting all sides of the chucked part to the brushes for the proper length of time. Since every part bears against the brush with the same amount of pressure,



uniform and consistent results are obtained. In dry brushing, metal particles are drawn off by a vacuum system, using hoods about the brushes to carry off the chips. Each machine is specifically designed to deburr a special gear or part. **Fuller Brush Co., Machine Div.,** Hartford 2, Conn.

Circle No. **12** *on Reply Card*

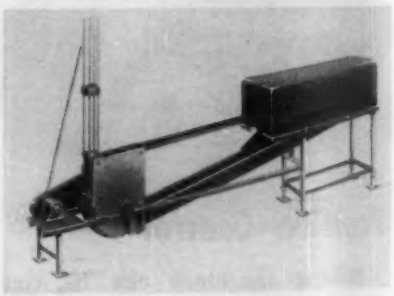


No. 13—

Automatic Die Sprayer

New unit called the Moto-Spray automatically sprays Renite to clean and lubricate top and bottom dies at the same time on presses and hammers. Moto-Spray is mounted outside the die block and, when actuated, automatically moves in between the dies, sprays both cavities with any pattern or quantity, reverses and returns to normal position at required speed, shutting off the Renite spray when it passes the end of the die cavities. When changing dies, the Moto-Spray can be swung out of the way and then can be completely adjusted in less than 5 min. It works at any forging speeds up to 100 or more strokes per hour. Two screws adjust the speed—one for the outward stroke and the other for the return stroke. Moving a reversing cam determines the length of stroke at which it automatically reverses and returns. Illustrated model has adjustable stroke of 0 to 18 in. Moving another cam determines the path of the stroke where Renite will automatically be sprayed on die cavities and then shut off. Nozzles can be changed quickly to give various patterns or a number of jets—one up and one down, two up and two down, four up and four down, four up and eight down, spiral jets or other combinations of dual nozzles —can be supplied. On upsetters, Moto-Spray is mounted vertically above the die blocks and moves downward and then returns—cooling and lubricating dies and/or punches. **Renite Co.,** P. O. Box 365, Station A, Columbus 1, O.

Circle No. **13** *on Reply Card*



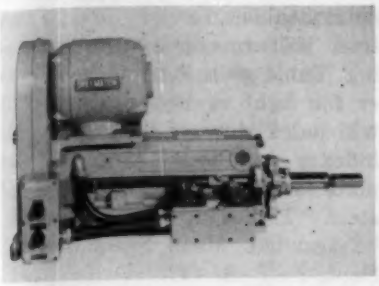
No. 14—

Electronic Can Sorter

Several grades of canned goods can be run through the same cooker at the same time through use of new electronic marked-can sorter. Unit separates the cans as they are discharged from the cook-

er, and sends them to multiple labeling and/or casing lines. Each sorting machine can simultaneously direct as many as six mixed grades or products accurately. Sorting occurs through electronic detection of a premarked spot on the can. Patented system of premarking and multigrade detection with the resulting rapid movement of cans into the proper lines automatically has been tested and approved under production line conditions. **Dudley Machinery Corp.**, Santa Clara, Calif.

Circle No. **14** *on Reply Card*



No. 15—

Deep Hole Driller

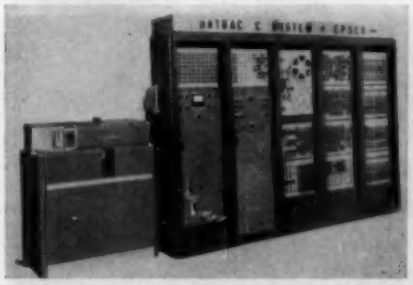
Self-enclosed, hydraulic feed power unit for deep hole drilling in crank, camshafts, etc. is addition to line of package-type power units. Deep hole driller features drilling steps or increments which can be preset to any depth multiples, and a rapid approach and return which need no further adjustments. There is no appreciable heat rise due to a locked-circuit feed. Unit can drill holes in metals ranging up to 40 Rockwell C. Drill spindle and pumps are integral and in line with the drill thrust. Standard deep hole drilling units have a 10-in. stroke. **Drillmation Co.**, 21511 John R St., Hazel Park, Mich.

Circle No. **15** *on Reply Card*

No. 16—

Data Reduction System

New 18-channel simultaneous sampling system which converts voltage data into magnetic tape and IBM punch cards is suitable for a wide variety of data reduction applications. The system is entirely automatic in operation, although provision is made for both manual control and synchronization to an external timing source.

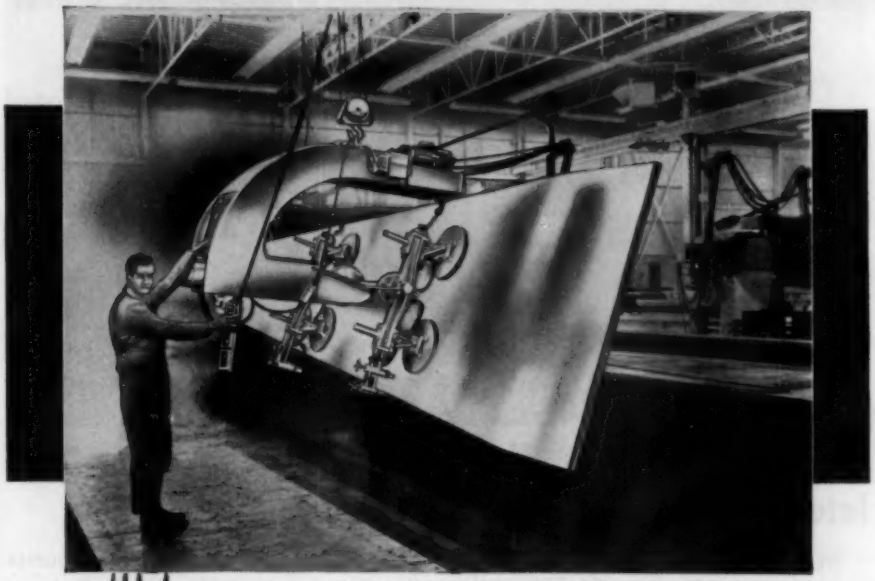


The system automatically checks the accuracy of data as it is being transferred from the magnetic tape to the punch cards. Called the Datrac C, the device simultaneously samples and converts 18 bipolar input voltages into their numerical representation and stores the resultant digital codes on a magnetic tape. Up to 750,000 individual data points may be monitored during the data run. Following the data run, the Datrac C transfers the information from the magnetic tape onto IBM punch cards. **Epsco Inc.**, 588 Commonwealth Ave., Boston 15, Mass.

Circle No. **16** *on Reply Card*

NOW LIFT BY AIR with LITTELL

VACUUM SHEET LIFTERS

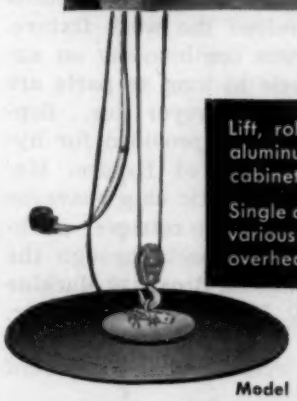


Model No. 2830-RO

8-Cup Littell Roll-Over Sheet Lifter handling 2,000 lb. aluminum airplane wing with overhead crane in aircraft plant. One man operation.

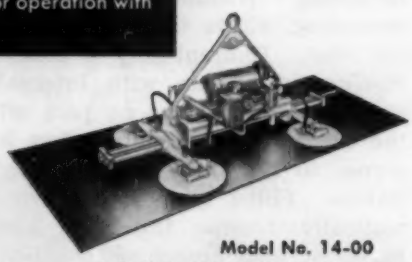
Lift, roll-over and transport sheet steel, aluminum, ingots, glass, plywood boxes, cabinets—regardless of weight—BY AIR!

Single and multi-cup models available for various weight loads—for operation with overhead cranes.



Model No. 122550

Single cup Littell Sheet Lifter with movable shackle bolt. Permits object to be lifted in vertical or horizontal position. One man operation.



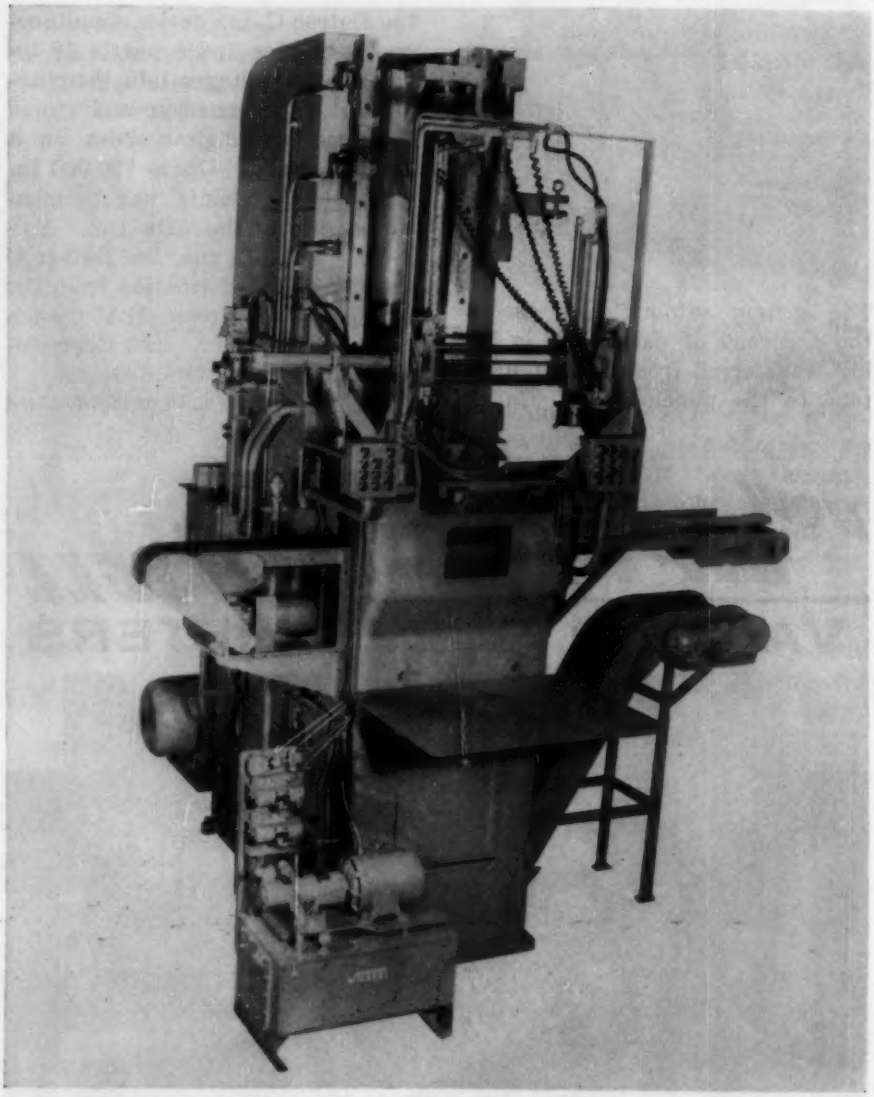
Model No. 14-00

4-Cup Littell Sheet Lifter handling sheet steel. Adjustable cup centers from 18"-24" in width; 36"-60" in length. One man operation.

Write for FREE Catalog!

F. J. LITTELL MACHINE CO.

AIR-VACUUM DIVISION • 4105 RAVENSWOOD AVENUE CHICAGO 40, ILLINOIS



No. 17—

Internal Spline Broaching Machine

New 30-ton, 60-inch stroke, pull down broaching machine automatically broaches ten internal splines in an automotive brake drum in one pass. Designed for conveyor line automation, machine automatically picks up parts coming in from a conveyor line, transfers them to broaching position and after broaching, ejects them back onto the line. Hydraulically operated loading mechanism with internal chucking device picks up part off the conveyor line and transfers it across to the sliding workholding fixture. Collet type fixture automatically clamps the part and moves it into broaching position. Broach is pulled down through the part, broaching ten 1-inch wide splines in the workpiece. At end of the broaching and return stroke the loading unit moves across on guide rails, picks up another part from the conveyor line and returns ready to reload the work fixture. Machine runs continuously on automatic cycle as long as parts are coming from conveyor line. Separate oil tank is provided for hydraulically operated fixture. Machine has automatic chip conveyor unit. Full follow-up retriever mechanism follows broach through the stroke. **American Broach & Machine Co.**, 415 W. Huron St., Ann Arbor, Mich.

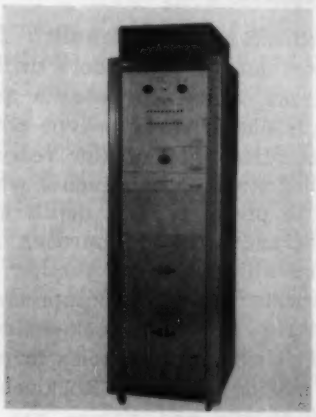
Circle No. **17** *on Reply Card*

No. 18—

Feed Table

Combination of new fluid feed rotary table with timer, air hammer, air press, drill presses, etc. provides almost completely automatic operation. Small parts are delivered to drill, tap, swage, stake, etc., in 8, 12, or 24 stations accurate to 0.003-inch by rotary table. Device provides positive, uniform air-hydraulic indexing. Table gives smooth, even power for light or heavy weights. It will index slow or fast, up to 2800 indexes per hour. Standard dial plate is ½ by 12 inches of ground steel. Tables up to 20 inches can be handled. **Mead Specialties Co.**, Dept. FFT-46, 4114 N. Knox Ave., Chicago 41, Ill.

Circle No. **18** *on Reply Card*



No. 19—

Voltage Encoder

Translation of the output of analog sensory devices into the binary numbers required in digital computing facilities used for real time data processing, or for binary coded control applications is performed by analog to digital encoder. Other systems applications are those in which analog information must be transmitted or recorded digitally. All-electronic device provides fast, precise and dependable conversion of analog voltages to binary codes. Encoder is asynchronous and is capable of a conversion rate up to 15,000 ten-

bit codes per sec with a precision of 0.1 per cent. Output of the encoder can be modified to present the digital number either in parallel or serially with the most significant digit first. High sensitivity and freedom from overload resulting from large differences between the voltages being compared is achieved by using nonlinear, negative feedback in a wide-band, direct coupler amplifier. Chopper stabilization provides drift-free operation. Vacuum tubes and choppers are replaceable from the rear of the encoder rack; wiring and all other components are located behind removable front panels to provide easy access. **ACF Electronics**, Dept. 204, 800 North Pitt St., Alexandria, Va.

Circle No. **19** *on Reply Card*

No. 20—

Stitch Welding Head

Contoured seam welds are possible through use of stitch welding head which guides spot welding electrodes. Either spaced or overlapping spots on any contour pattern may be used, permitting more freedom in product design than has previously been available. Stitch head may be mounted on any press welder and replaces the upper electrode. Indexing head is water cooled for high production. Operation speed of welding head is up to 100 spots per minute, depending on material being welded. Maximum radius of pattern is 3 inches; minimum radius is ½-inch; and maximum electrode force permissible is 4000 lb. **Taylor-Winfield Corp.**, Warren, O.

Circle No. **20** *on Reply Card*

New Handling System

increases production while eliminating two lines

In one of the automotive industry's newest plants, production of frames for 1955 models was lagging, even though 6 lines were being used. Then Planet engineers were consulted.

They designed and installed a new frame handling system which exceeds current production requirements, doubling the output of the old-style line. *Now only 4 lines are used.* In addition, quality has been improved.

Here's how the system operates. The component parts of the frame are delivered by trolley conveyor to a frame assembly conveyor where they are automatically positioned for tack welding. The assembled frame is then discharged on to the frame welding conveyor illustrated above.

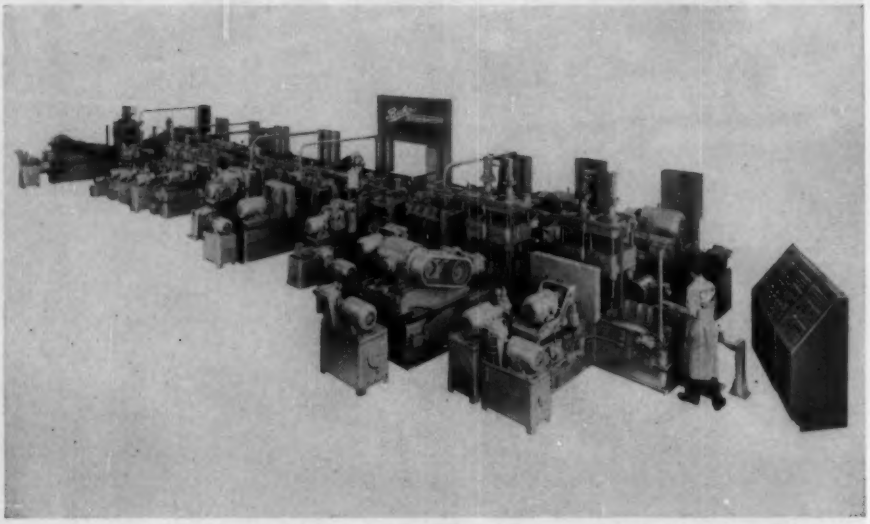
Here the frames are automatically rotated, 90° at a time so that all finished welding is done on a horizontal plane as the frames move by each welding station. Frames are then automatically conveyed through checking, cleaning, and painting operations.

If you have a production problem, why not consult Planet Corporation engineers? Write or phone today. There is no obligation.

PLANET CORPORATION
1810 SUNSET AVENUE
LANSING, MICHIGAN

- CONVEYORS
- ENGINEERED SYSTEMS
- FOUNDRY EQUIPMENT
- AUTOMATION
- STEEL FABRICATION

"IT PAYS TO PLAN WITH PLANET"



No. 21—

Automatic Transmission-Case Processor

New 45-station machine performs 249 drilling, boring, reaming and tapping operations on 52 automatic transmission cases per hour. Parts are received with three surfaces milled. Machine then automatically handles and repositions the part to present proper surfaces for machining. When processing has been completed, every drilling, boring, reaming and tapping operation is accomplished. Machine which combines a battery of three machines, features electronic mechanisms to aid in machining operations. Typical example is the automatic probing of each hole before it is tapped. Every moving component of the machine is automatically lubricated and each way is constructed of hardened and ground laminated tool steel. **Buhr Machine Tool Co.**, Ann Arbor, Mich.

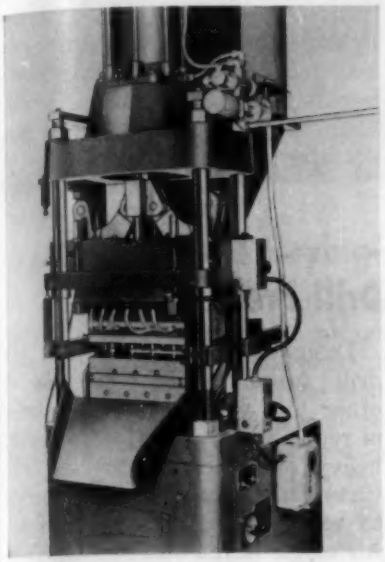
Circle No. **21** *on Reply Card*

No. 22—

Molding Machine

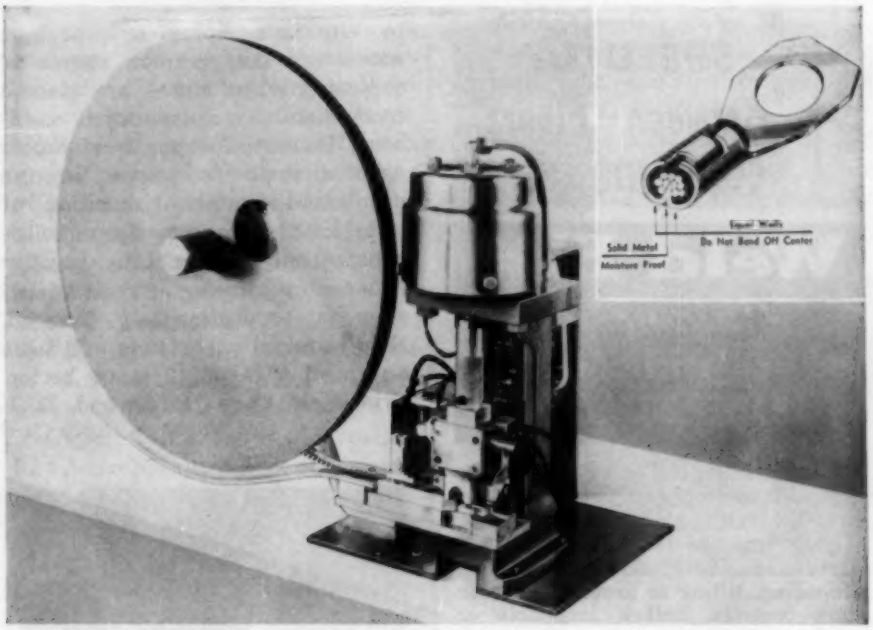
Designed for molding fast curing thermosetting material, high speed, fully automatic molding machine is capable of cycling in four seconds. Machine, called the Automold, can feed any standard thermosetting material including alkyds. All moving parts are mechanically positive and the only electrical circuits pertain to heating of the mold, timing the curing cycle of molded parts and one limit switch for safety. Variety of plastic items, molded of fast or slow curing thermosetting materials can be produced easily. Items such as appliance parts, automobile accessories and electrical attachments, often made of fast curing alkyds, are molded at low cost. Press utilizes advantages of an air operated cylinder. Ejecting parts from the press is provided by lifters placed on the core side. This process raises parts

out of the cavities and above the lower half of the mold. By means of ejector pins the parts are stripped from the cores and deposited on



an inclined table from which they are sent to their respective bins. **Automatic Molding Machine Co.,** 3217 Exposition Pl., Los Angeles 18, Calif.

Circle No. **22** *on Reply Card*



No. 23—

Insulation-Piercing Terminal

New design pricker-type terminals are produced in strip form and supplied on reels. Method employs an improved type terminal attaching machine operated by limit switch or foot pedal, with practical application of 2000 terminations per hour. Improved method of insulation piercing assures users of corrosion-free, electrical connections in stranded and tinsel wires. Design improvement provides the following advantages: lances are formed from solid metal

Now you can buy CUSTOMIZED conveyors in pre-fabricated STANDARD sections

In a single glance, you can see all of the advantages of MAY-FRAN STANDARDIZED components.

The five standard sections shown can be assembled to form virtually any type of *"customized"* conveyor for the handling of stampings, formed metal parts, forgings, automotive scrap, chips and turnings.

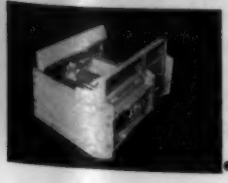
Straight sections . . . concave or convex sections . . . take-up charge and discharge-end sections can be furnished to meet specific requirements of belt width as well as load bearing and volume capacities.

A single glance at the MAY-FRAN conveyor standardization program, and you will see savings never before possible. In addition you will see unsurpassed conveyor flexibility.

MAY-FRAN . . . a name long recognized in the materials handling field . . . is **FIRST** again with *standardized* components for your *customized* installation.

Write today for complete information.

..AUTOMATION.....AND YOU!



6030-MP

MAY-FRAN ENGINEERING, INC.

1761 Clarkstone Road • Cleveland 12, Ohio

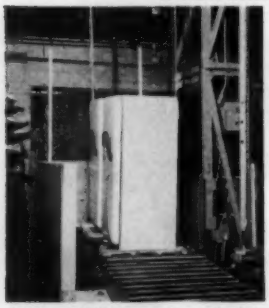
SPEED UP
"Between-Floors"
CONVEYOR LINES

Weld-Bilt
Automatic
"VERTICAL
TRANSPORTATION"

Weld-Bilt Floor-to-Floor Elevators are designed to improve your conveyorizing between two or three floor levels. Highly versatile in application, they provide completely automatic loading, unloading, lifting or lowering — with limit controls, brakes, inclinable or mechanical platforms, selector push buttons in any combination to suit your product and conveyor systems.

TYPICAL WELD-BILT
"VERTICAL TRANSPORTATION"

Freezers automatically conveyed to elevator on top floor. Freezer weight trips controls to start descent.



Roller platform automatically tilts at lower level to discharge freezers to conveyor. Load release starts elevator ascent to top floor.

If your production flow can benefit by floor-to-floor conveyorizing, write for suggestions on Weld-Bilt "Vertical Transportation."

"Weld-Bilt" PRODUCTS

Weld-Bilt Automatic Conveyor-Lifts Elevators, Portable Elevators, Drum Elevators, Lift Trucks, Pallet Trucks, Hydraulic Lift Tables, Skid Platforms, Special Equipment.

SEE OUR EXHIBIT MATERIALS HANDLING SHOW — JUNE 5-8 —BOOTHS 210-212-309-311.

WEST BEND EQUIPMENT CORP.
MATERIALS HANDLING ENGINEERS
347 WEST WATER STREET • WEST BEND, WIS.

to eliminate holes or openings which are the common source of corrosion when lances are pierced from metal by conventional methods. Increased strength of lances enables them to pierce through dead center without bending or collapsing. As area of contact is substantially enlarged by positive full center piercing, circuit resistance is proportionately lowered. New terminal withstands pull tests on tinsel wire of 15 lb or better. **Crimpweld Corp.**, Edgewood, R. I.

Circle No. **23** *on Reply Card*

No. 24—

Carton Imprinter

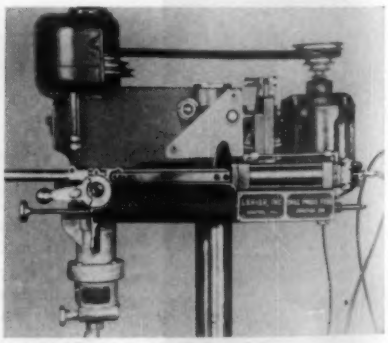
Cartons are automatically fed, imprinted, and power stacked at a rated speed of 10,000 pieces per hour by new machine. Designed to save time, labor and materials in imprinting folded boxes and cartons, bags, tags and pack-envelopes, as well as cardboard stock, imprinter enables users to eliminate large, varied and expensive inventories of cartons and other containers ordinarily printed in advance in different sizes and quantities. With new machine, cartons are imprinted as needed. Imprinter can handle anything from small envelopes to large cartons. It feeds automatically to a printing drum which applies fast-drying ink. In the same operation, a large capacity stacker automatically handles output for efficient unloading. Special feature of machine is that it can be set up quickly for changes in imprint and piece sizes without use of tools. Other features include a liquid inker that can be filled without stopping the machine, and outside controls in one panel. Imprinter can accommodate material sizes from 2½ by 2½-inches up to 18 by 18 inches, and thicknesses from 0.010 to 3/16-inch. It will imprint an area up to 4 by 18 inches in any direction, using either rubber mats or metal type, and can handle uncoated, varnished or paraffin surfaces. **Pitney-Bowes Inc.**, Stamford, Conn.

Circle No. **24** *on Reply Card*

No. 25—

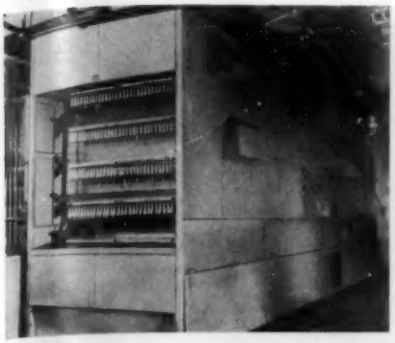
Drill Press Feed

Designed to be attached to any drill press, milling machine or other tool where controlled power is required to rotate a feed shaft, heavy duty drill press feed converts hand operation and control to semi or completely automatic. Air motor in the unit operates from shop air pressure to drive a rack and pinion, lowering or retracting the quill assembly of the drill press automatically at precisely preselected speeds. The power stroke is the outward stroke of the air clyinder, thus utilizing full available power. Stroke is hydraulically checked at a preset point to give controlled speed of



the work stroke and to lessen drill breakage at break through point. A built-in impulse switch permits complete electrical sequencing with other equipment, such as a rotary table. Machine provides uniform production since each stroke is automatically controlled by pneumatic power plus hydraulic check at the critical break through. Models use 2 or 3-inch bore air motors and provide full 360-degree pinion shaft rotation with 3⅜-inch drill press stroke on most presses. **Lehigh Inc.**, Air Control Div., 1500 Lehigh Dr., Easton, Pa.

Circle No. **25** *on Reply Card*



No. 26—

Dip Coating and Drying

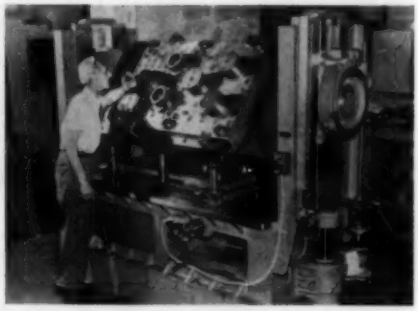
Conveyorized two-dip system for application and drying of a primer and a finish coat to small parts at a high production rate can be modified to meet individual requirements. Equipment produces a coating of uniform thickness that is drain-free and tear-free, and dries it in an atmosphere independent of ambient humidity and temperature. Automatically controlled extraction angles and extraction speeds, and the drying in a forced draft controlled atmosphere make high production conditions possible. Dip coating technique can be used for the application of protective or decorative coatings of lacquers, enamels, paints or varnishes, as well as various types of plastic coatings. Equipment affords reduced coating material costs by elimination of overspray and minimization of diluent usage, improved quality of work including uniformity and continuity of coverage, and increased production. Special chain attachments permit one operator to load and unload work carrying racks on the internal dual chain conveyor. Lift doors give access to removable dip tanks for servicing. Recirculation of coating materials in the tanks provides proper dispersion of pigments. Overflow drains, part of the recirculation system, assure maintenance of constant level and removal of trapped air. **Applied Engineering Associates,** 1952 Flushing Ave., Brooklyn 37, N. Y.

Circle No. **26** *on Reply Card*

No. 27—

Die Handler

Largest model in line of die handlers, new machine handles dies or molds measuring 36 by 75 inches, weighing up to 6000 lb. Its top platen is of cast Meehanite and is raised and lowered with heavy precision lead screws, driven by a 2 hp. electric motor mounted in the base. Under power, the top platen



rises at the rate of 12 inches per minute. Fine adjustments in position can be made with an auxiliary hand crank. Platen can be rotated with power supplied by a ¾-hp. electric motor. It is also equipped with an auxiliary hand crank for rotational movement. **Hansford Mfg. Corp.,** 1239 University Ave., Rochester 7, N. Y.

Circle No. **27** *on Reply Card*

LOW COST—HIGH QUALITY

Relays-a-Plenty

Potter & Brumfield, with its many years of Engineering and Production experience, builds relays to all quality levels.

Relays from the most exacting to the simplest in operating specifications are readily available at P&B.

Small or Large quantity orders receive the same careful attention by the people that have the "Know How."

Let Potter & Brumfield engineers become part of your design group in selecting the correct type of relay to meet all requirements.

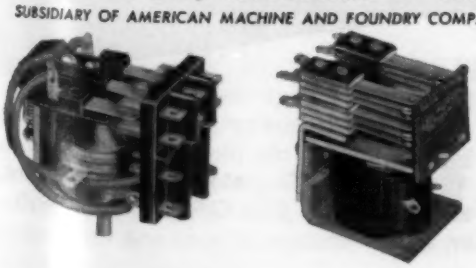
For quick delivery over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

Send your specifications for samples and quotations.

Potter & Brumfield

PRINCETON, INDIANA inc.

SUBSIDIARY OF AMERICAN MACHINE AND FOUNDRY COMPANY



Automatic MONORAIL

Delivers 25 Tons Daily

One man uses push-button control to load, automatically dispatch, over four tracks, and dump fresh core sand at any of 24 stations.

This flexible American Monorail System is tied in with manually operated track switches. Stations may be increased to 16 per track.

This American Monorail installation is typical of hundreds which have sharply cut handling costs.

Today call your nearby American Monorail Representative or write us.

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AMERICAN OVERHEAD HANDLING EQUIPMENT

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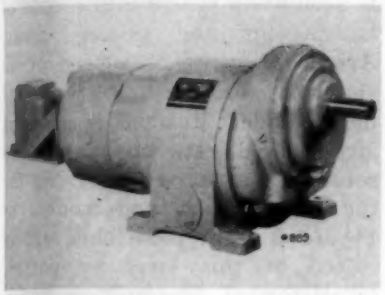
[IN CANADA—CANADIAN MONORAIL CO., LTD., GALT, ONT.]

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 115



No. 28—

Gear Motor

Developed for use on a new, high speed palletizer, special duty gear motor runs forward and plugs to a stop, applying the brake at the same time. Zero speed switch is mounted directly on the motor shaft extension through the brake. As the speed of the motor approaches zero, the zero speed switch disconnects the motor winding from plugging reverse, but leaves the magnetic brake connected and applied. Motor repeats this cycle a number of times as cases are stacked "in tie" on the pallet. Motor then has a reverse running period plugging to a stop while the pallet is unloaded or indexed to another position. Company offers special engineering service of this type in addition to standard lines of motors. **Sterling Electric Motors Inc.**, 5401 Telegraph Rd., Los Angeles 22, Calif.

Circle No. **28** *on Reply Card*

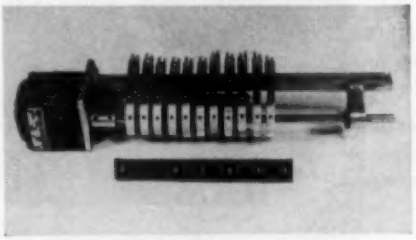
No. 29—

Solenoid Air Valve

Available with either open or closed centers, new three-position, four-way double solenoid air valve features a neutral position. On the open center Model No. 1013, both cylinder ports are open to exhaust and pressure is blocked when solenoids are de-energized—leaving the cylinder rod in a free state. When energized, one port opens to line pressure; the other remains open to exhaust. Ports of the closed center Model No. 1023 are blocked from pressure and exhaust when solenoids are de-energized, holding the rod in a locked position. When energized, one port opens to pressure; the other opens to exhaust.

Both models are available in ⅜-inch port size. Side porting is standard; bottom ports are available upon request. **Mechanical Air Controls Inc.**, 10030 Capital, Oak Park, Detroit 37, Mich.

Circle No. **29** *on Reply Card*



No. 30—

Interrupter Units

Used as a standard item in telephone exchanges, motor driven interrupter is now available for use in automation and related work where reliability and accuracy are required. Two units are available —one containing from one to six circuits, the other containing from seven to 16 circuits. Drive motor has an internal gear reducer, totally enclosed. Standard 115 v., 60 cycle unit consumes only 10 w. Windings for other voltages and frequencies are available. Many output shaft speeds — 1, 2, 6, 7, 5, 10, 15 r. p. m. — are available. Machined nylon cams are used for long life, quietness and efficiency. Guaranteed accuracy for any point on any one cam is ±1.5 degree. Guaranteed accuracy between points on any two cams is ±2.25 degrees. Cams are keyed to the shaft. Seven types of telephone style spring pile-ups are available. Nylon pile-up followers are used for nylon-to-nylon contact with the cams. This arrangement requires no maintenance or lubrication. Contact rating for 115 v. a. c. is 2 amp., resistive load. **National Pneumatic Co. Inc. & Holtzer-Cabot Divs.**, 125 Amory St., Boston 19, Mass.

Circle No. **30** *on Reply Card*

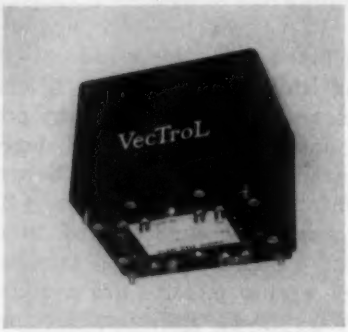
No. 31—

Strip Chart Printer

Remote selection of numbers or letters to be printed on strip charts is made by new device. Print wheel on the unit can have 8, 10, 12, 18 or 24 positions, with the position being selected from a remote point, then caused to print for the purpose of identifying events on the recorder chart. The unit, called the RI-3 Identichart, is useful for identifying range, chart speed, channel number or other variation that needs to be identified when

the chart is reviewed. Device can have two print wheels, each independently set by separate, remote switches. The printing pulse causes the device to print whatever characters have been selected. Unit does not interfere with or obscure the recording procedure. It can be made to operate on any a. c. or d. c. voltage from 24 to 110 v. **Royson Engineering Co.,** Hatboro, Pa.

Circle No. **31** *on Reply Card*

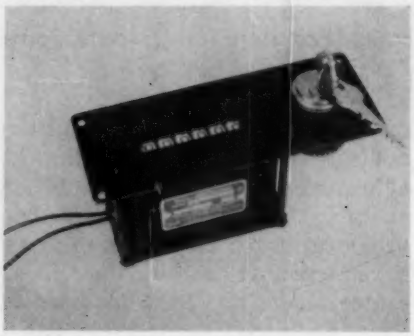


No. 32—

Packaged Grid Control

New packaged thyratron grid control eliminates all control tubes in feedback circuits for voltage regulated power supplies, adjustable speed motor drives, program speed controls, servo motors, magnetic or eddy current clutch or brake controls, welding or electrochemical current control, automatic battery chargers, machine tool automation and process controls in general. Unit is designed for proportional control of 60 cycle single-phase, half or full wave thyratron outputs up to several kw., with d. c. control signal less than 1 mw. Four isolated d. c. control windings will provide control in accordance with several independent signals. Grid control unit is made up of a patented sensitive phase shifting network of static components sealed hermetically in a can, and providing phase shift up to 300 degrees. Linear porportional phase shift of 180 degrees is obtainable with small d. c. control signal. No grid bias is required to insure thyratron cutoff when control signal is removed. **VecTrol Engineering Inc.,** P. O. Box 1089, Stamford, Conn.

Circle No. **32** *on Reply Card*

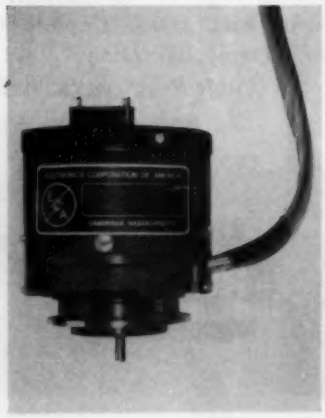


No. 33—

Magnetic Counter

Designed for panel mounting where remote indication is required, new magnetic counter is 1.68 inches deep, 2.1 inches high and 5.11 inches wide, with a capacity of 1000 counts per minute. Tumbler lock on the unit prevents tampering; one turn of the key resets all six figures to zero. Power consumption is 8 w. Counter is available in 110 and 220 a. c. and d. c. models. **Veeder-Root Inc.,** Hartford 2, Conn.

Circle No. **33** *on Reply Card*

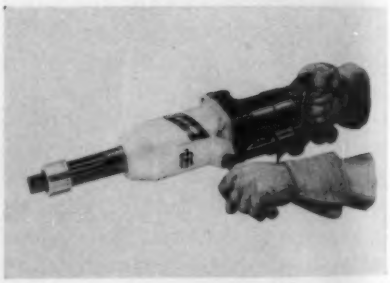


No. 34—

Analog-Digital Converter

Lightweight, 13-channel encoder reads shaft positions to an accuracy of one part in 8192 (2^{13}). Instrument is applied where position of a rotating shaft is required either as an input to some controlling device, or for data reduction. Output of converter is in cyclical binary code. Converter employs no slip rings or moving contacts, no gears and no circuits in which the accuracy of any one reading depends on that of a preceding reading. Photoelectric means are employed to pick off shaft position with no frictional drag on the shaft. Glass disk is mounted directly on the shaft, and is accurately scaled into a code of transparent and opaque areas. Areas constitute a pattern of 13 channels forming the cyclical binary code. Readout is made at any desired rate up to 100 per second. Output is in parallel for the 13 channels, and mounts to 1½ to 3 v at 3000 ohm. It is raised to this level by potted, transistorized preamplifiers which are built into the unit. **Electronics Corp. of America,** 720 Beacon St., Boston, Mass.

Circle No. **34** *on Reply Card*



No. 35—

Torque Control

Heavy nut running tool designed for torque control handles torques up to 550 ft.-lb. Tool applies the torsion bar principle for torque control on nut running. It has multiple torque settings that are easily changed with the aid of an adjusting collar and torque jig. Device, called the Impactool, shuts off automatically when the preset torque is reached, thus eliminating over-torque. Impactool is reversible, having full power in either direction, and does not require a clutch. Another model, Size 5040T, handles torques up to 90 ft.-lb. **Ingersoll Rand Co.,** 11 Broadway, New York 4, N. Y.

Circle No. **35** *on Reply Card*

No. 36—

Control Valve

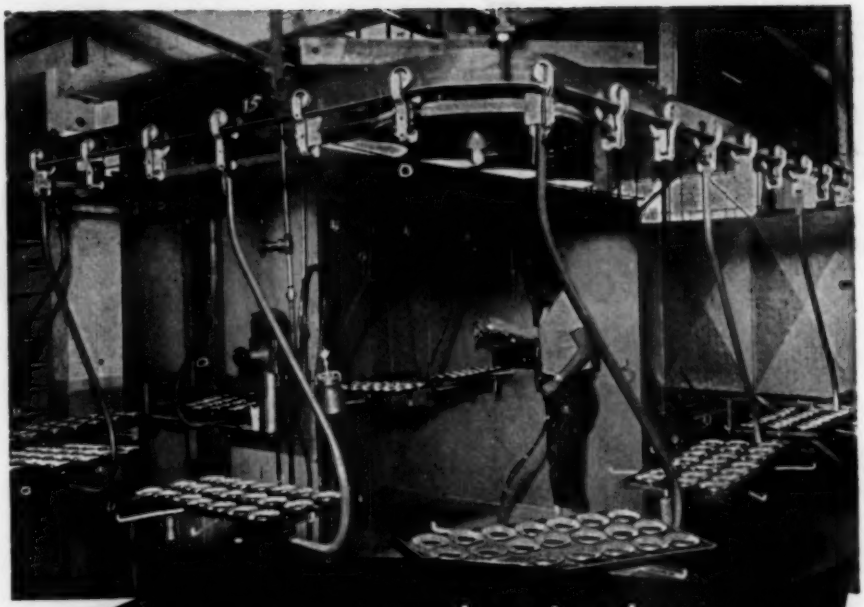
New body design of S-3000 line of control valves provides an extra large bowl capacity to insure a high coefficient of flow without involving excess body weight. Need for a blindhead is eliminated, since all internal parts are removable through the valve bonnet, and since action may be reversed by inverting the superstructure. Plug in valves 2 inches and larger are of balanced design and can be supplied with a special device for tight shutoff. Superstructure is a new concept in the design of diaphragm motors. Illustrated valve is assembled for air-to-open action. By inverting the topworks, without interfering with the open yoke or releasing compression of the stem packing, the valve is converted to air-to-close action. An all-purpose valve in its simplest form, Model S-3000 can be converted into a special valve providing balanced control with tight shutoff at any temperature and pressure conditions. **Hammel-Dahl Co.**, 175 Post Rd., Warwick Industrial Park, Providence 5, R. I.

Circle No. 36 on Reply Card

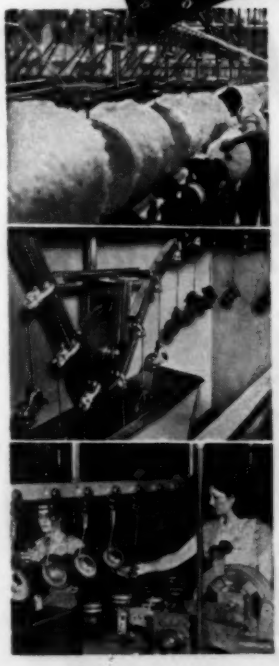
No. 37—

Wear Resistant Piping

Designed for hydraulic or pneumatic materials handling systems, Ashcolite metal pipe with sleeve couplings and complete line of piping accessories afford high re-



...here's why
BUSCHMAN
OVERHEAD CABLE
CONVEYORS
give you
GREATER SAVINGS!



LOWER INITIAL COST — Buschman "Universal" Cable Conveyors not only cost less but also outperform heavier, more expensive conveyors for light and medium-weight applications.

LOWEST MAINTENANCE COST — Constant take-up readjustment is eliminated because of a safety factor of 14-to-1 or greater.

LOWEST REARRANGEMENT COST — Exclusive Buschman design plus lightweight all-bolted construction make future changes fast and easy.

MORE COMPACT DESIGN — Shorter radius curves and dips permit more complete utilization of production and storage space . . . both overhead and at work level . . . require less room inside industrial ovens, washers, dip tanks, etc.

SMOOTHER OPERATION — There are no pulsations or jerks to damage delicate parts or finishes when your product is handled on Buschman Cable Conveyors.

PRE-ENGINEERED — Using Buschman standard stocked parts, your own crew can set up a "Universal" Cable Conveyor tailored to your specific requirements.

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PRODUCE MORE . . . FOR LESS
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THE E. W. BUSCHMAN COMPANY
4544 Clifton Avenue • Cincinnati 32, Ohio
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Complete Conveyor Systems For All Types of Industries • Engineered • Manufactured • Installed

Saves 40% Space!

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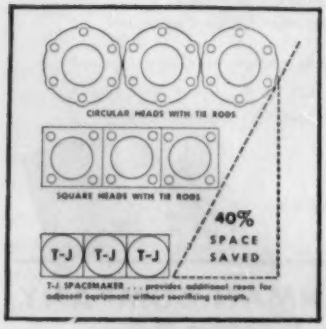
Spacemaker CYLINDERS

Offer All The Extras As Standard!

- NEW *exclusive* Ingenious Cushion Designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion
- Compact design eliminates tie rods, saves up to 40% space
- Proven Performance . . . with Extra High Safety Factor
- Hard Chrome Plated Bodies and Piston Rods (Standard, at no extra cost)
- OIL pressure up to 750—AIR to 200 P.S.I.


CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
T-J
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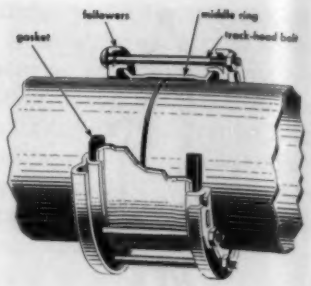
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

You'll find many answers to *automation* in your plant with T-J Spacemaker Cylinders! Designed with years-ahead features for top performance and dependability. Wide range of styles, capacities . . . for all kinds of push-pull-lift operations . . . reduces man-hours and costs! Write for bulletin SM-155-2. The Tomkins-Johnson Co., Jackson, Mich.

MEMBER OF THE NATIONAL FLUID POWER ASSOCIATION

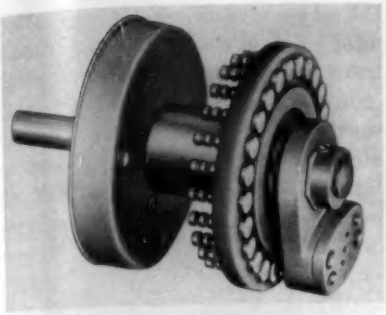
T-J TOMKINS-JOHNSON

RIVETORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS



sistance to wearing action of abrasive materials, uniform composition of pipe, true dimensions of pipe diameter and wall thickness, and a simplified coupling arrangement which provides ease of installation and maintenance. Piping arrangements for materials handling systems are easily made from sections of plain end pipe joined by illustrated gasketed sleeve coupling. Adaptors, similar in design to the sleeve coupling are used to connect the pipe to flange assemblies of all types, such as flanged pipe, fittings, machinery, etc. Other accessory items for the construction of piping systems include: blind flanges to close open ends of pipe runs, and bend fittings specially designed to minimize abrasive wear and friction loss. Ashcolite metal is composed of a chrome-iron alloy cast by the sand spun process. This results in pipe with hardness ranging from 280 to 340 Brinell and with a tough, dense, close grained structure which is free from holes, slag and sand inclusions. The casting process retains the radial arrangement of the alloy crystals which makes a cast pipe more wear resistant than rolled or drawn steel pipe. Standard sleeve coupling illustrated permits quick and easy pipe connection. When the bolts are drawn up, gasket pressure against the pipe produces a tight but flexible seal which permits a 4-deg. angle of deflection per connection. Sections of pipe to be joined can thus be simply aligned. Sleeve type coupling also makes it relatively easy to rotate the pipe after installation to obtain uniform distribution of wear. Ashcolite pipe is available in sizes from 4 to 12 in. inside diameter and in lengths up to 16 ft. **Allen-Sherman-Hoff Co., 259 E. Lancaster Ave. Wynnewood, Pa.**

Circle No. **37** *on Reply Card*



No. 38—

Turret Type Contact

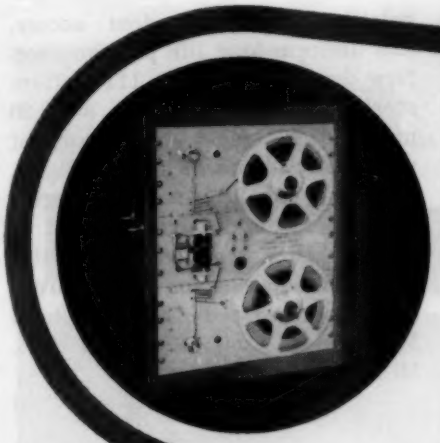
Designed for application in test equipment, instruments, guided missile control stations and aircraft and airborne fire control systems, turret type contact is used on all Daven rotary step type switches. New contact is a one-piece combination contact and turret lug, constructed of solid silver alloy which in turn is gold plated to provide corrosion resistance and to facilitate soldering. Turret lug contact combination is made with several notches to hold the wire mechanically as well as electrically. **Daven Co.,** Livingston N. J.

Circle No. **38** *on Reply Card*

No. 39—

Magnetic Storage Drum

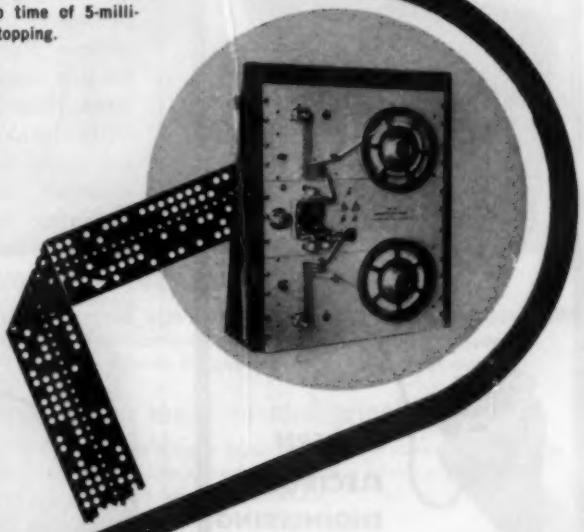
Designed for storage of information with computer elements such as digitizers, punched cards or tapes, magnetic tapes, electric typewriters, high speed printers, and graphic display platters, magnetic information storage drum has a capacity of 42,000 binary digits and a nominal speed of 3550 r. p. m. Drums have noncontact recording and playback, alterable yet non-



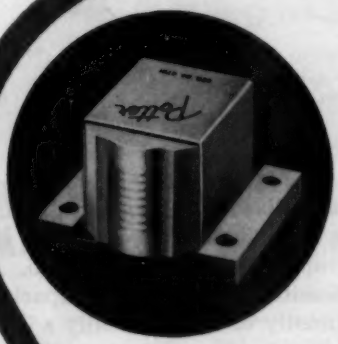
headquarters for digital magnetic and perforated tape handlers

Model 902 Magnetic Tape Handler treats the tape gently while providing a start/stop time of 5-milliseconds. Fully reversible without stopping.

Model 903 Perforated Tape Reader provides a 5 millisecond start time and stops on the character at 300 characters per second and on the character following a stop code at 600 characters per second.



The Potter Digital Magnetic Head eliminates "digit drop-outs" due to oxide collection. Phosphor bronze head mount provides close tolerances insuring complete interchangeability of tape from one machine to another.



Whether your data processing requirements call for perforated or magnetic tape handling, Potter offers a complete line of high-speed equipment to meet your needs . . . for either intermittent or continuous playback with speeds of up to 60 inches per second and start/stop times of less than 5-milliseconds!

Servo-controlled tape drives permit fast starts and stops without tearing or spilling tapes. At 30 inches/second speed, less than ⅛" of tape is consumed in a start/stop cycle!

For complete specifications on Perforated Tape Readers, Magnetic Tape Handlers and Digital Magnetic Recording and Playback Heads, write TODAY:

Potter

POTTER INSTRUMENT CO., INC.
115 Cutter Mill Road
Great Neck, New York

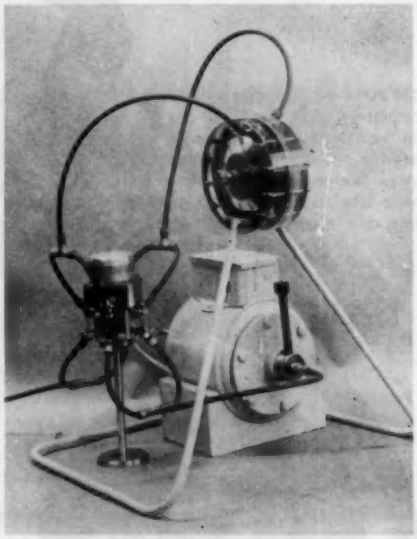
volatile storage, random access, and uniform long life performance. New drum, Model ERA 1114, offers storage of information on over 20 information tracks by means of magnetized spots or binary digits. It has a vertically mounted, integral drive motor and is constructed to withstand extreme environmental conditions. **Remington Rand Univac Div., Sperry Rand Corp.,** 1902 W. Minnehaha Ave., St. Paul W4, Minn.

Circle No. **39** *on Reply Card*

No. 40—

Downhill Pumping

Liquids or gases are accurately metered against negative discharge pressures by new controlled volume pumps. Pumps are well suited for all low capacity flow control problems that involve metering from high intake to lower discharge pressure. Units are immune to pressure variations in the system, requiring only that intake pressures be maintained at least 5 psi



above discharge pressures. Pumps are available in four standard sizes of approximately 3, 15, 75, and 375 milliliter per cycle. Capacity is manually or automatically adjustable during operation through either stroke length or speed control. Leakproof construction with no running seals or stuffing boxes enables pump to easily handle dangerous and highly corrosive materials. **Milton Roy Co.,** Station L, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

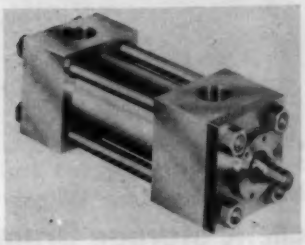
Circle No. **40** *on Reply Card*

No. 41—

General Purpose Relay

Particularly adaptable to aircraft and mobile equipment applications where severe shock and vibration are encountered, new Model DO is addition to line of general purpose relays. Unit has a maximum contact combination of four pole, double throw. Contact and terminal insulation is of molded phenolic material. Design of the molded parts around the moving contact arms affords maximum protection against mechanical injury. Contact rating is 10 amp. at 115 v. a. c. or 32 v. d. c. noninductive load. Relay is available in a wide range of operating voltages for either a. c. or d. c. **Ohmite Mfg. Co.,** 3682 Howard St., Skokie, Ill.

Circle No. **41** *on Reply Card*



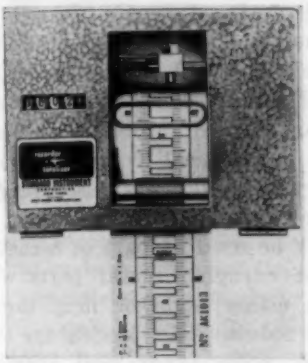
No. 42—

Hydraulic Cylinders

Built for dependable performance under severe industrial operations, heavy duty hydraulic cylinder is rated at 2000 p. s. i. Cylinder features heavy walled seamless steel tubing microhoned for minimum friction; rolled steel heads recessed to confine the tube,

prevent breathing and provide additional protection against leakage under the most severe usage; piston rods hard chrome plated, turned, ground and polished from stress relieved high tensile steel; multiple lip self-compensating rod gland packing providing excellent pressure sensitivity with long life. Packing is contained in a removable cartridge which facilitates replacement without disassembling the cylinder. Cylinders are available in bore sizes from 1½ to 8 inches. **Ortman-Miller Machine Co., 23 143rd St., Hammond, Ind.**

Circle No. **42** *on Reply Card*



No. 43—

Time Recorder-Totalizer

Continuous operation record of any electrically operated machine or process is provided by time recorder-totalizer. Chronologically marked tape from a large roll continuously passes through this instrument, recording the time and length of every *On* or *Off* period of the equipment. Where desired, a counting device can be furnished in place of the time totalizer for determining the number of operations or pieces produced or processed by machines such as punch presses, drill presses, stamping machines, injection molding equipment, etc. Totalizer gives total of the complete *On* time of the equipment. Unit can be installed either as an integral part of the equipment, as remote installation, or as a portable tool. Standard tape speeds available are: 1 inch per 5 minutes, 1 inch per 15 minutes, and 1 inch per hour. Device operates on 115 to 220 v ac, 60 cycle power. **Standard Instrument Corp. Div. of Heat-Timer Corp., 657 Broadway, New York 12, N. Y.**

Circle No. **43** *on Reply Card*

La Salle AUTOMATIC POWER WRENCH

practically eliminates breakage of cutting tools!

IT'S NEW!

two-speed fully automatic power

It's synchronized with the machine cycle to give you automatic engaging and disengaging of parts. Controlled torque eliminates positively all guesswork in clamping pressure.

operates on machine tool principles

A high speed low torque approach; a low speed high torque clamping; and a low speed high torque break clamp and a high speed low torque return.

STARTLINGLY DIFFERENT!

features fluid motor drive

You can clamp light parts or parts with thin-walled areas without fracturing and you can always repeat the clamping torque from cycle to cycle.

fits any type of production machine

They're designed to fit any special or any standard machine in use today—such as Multiple-Drilling Machines, Lathes, Boring Mills, Grinders, Screw Machines or Thread Millers

GOOD NEWS FOR PRODUCTION MANAGERS!

unit mounted quickly

The design permits either vertical, horizontal or angular mounting—to serve your particular needs.

now available in two standard sizes

Smaller model has a torque capacity up to 1200 inch/pounds; larger model from 800 to 5000 inch/pounds. To control and regulate properly a hydraulic power package is provided.

La Salle tool, inc.

ENGINEERING & BUILDING SPECIAL MACHINERY

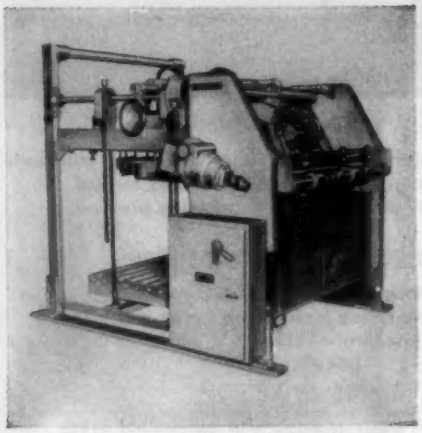
3840 East Outer Drive • Detroit 34, Michigan

DEXTER
AUTOMATIC METAL SHEET FEEDER

Metal sheets, automatically separated, picked up and advanced one at a time to feeding—in point of machine to which it is attached at speeds up to 150 sheets per minute.

Should two sheets adhere, they are automatically transferred to a reject tray. Rubber suction mouthpieces and drop rollers prevent scratching.

Standard Feeder handles metal sheets from 14" x 18" up to 36" x 44" between 24 and 38 gauge stock. Feeders for larger size and heavier gauge metal sheets also available.



Continuous reloading avoids machine stoppage. New loads are placed in feeding position, while machine is operating, thus maintaining continuous automation cycle.

Dexter Feeder may be attached to Metal Litho Presses, Coating Machines, Sorting Machines, Shears, Slitters, Sprayers, Punch Presses, Stove Pipe Machines, Buffers and numerous other metal working machines.

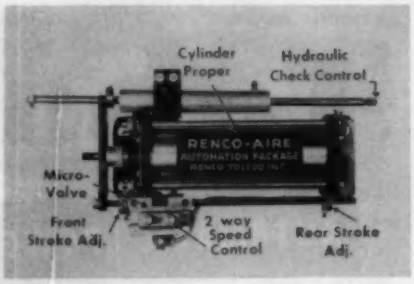
Custom built sheet feeders for handling paper, cardboard, corrugated and other types of sheets are available to meet specific requirements. Inquiries invited.

EST. 1880

DEXTER FOLDER COMPANY

General Sales Offices

330 WEST 42ND STREET
NEW YORK 36, N. Y.



No. 44—

Air Cylinder

Designed to convert such tools as hand mills, grinders, etc. for automatic table operation, new air cylinder with a microaction directional valve and adjustable two-way speed controls, complete with a fully adjustable hydraulic check, is available in any desired stroke. Several air units may be mechanically interlocked to provide multiple machine cycles. Cylinder is available in various mountings for immediate machine tool conversion. New microaction valve operates on pressures as low as 1 p. s. i. with full automatic valve action, and is readily adaptable for low or high pressure operation. Valve will operate at over 3000 cycles per min. and the built-in stroke adjustment can be controlled to ±0.001-in. Valve, which is entirely air operated, requires no electrical installation, thus eliminating explosion hazard and reducing cost. **Renco-Toledo Inc.,** Dept. A-1, 819 North Reynolds Rd., Toledo 7, O.

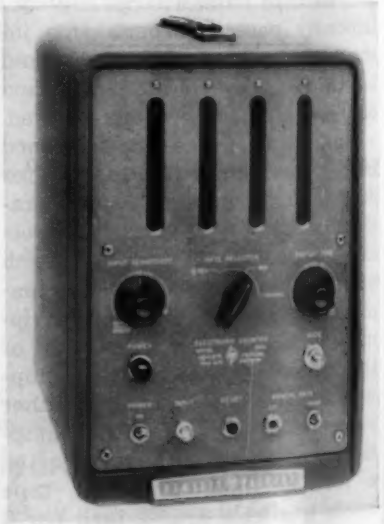
Circle No. **44** *on Reply Card*

No. 45—

Proximity Pickups

Designed for accurately counting or indicating metallic parts of any shape as they pass through a hollow coil, new type of proximity pickup transducer is ideal for counting or automatic batching of such metal or covered metal items as screws, nuts, washers, bolts, etc. Proximity pickup Model 4920 (No. 11 on photograph) is available in 15 sizes and directly interchangeable with standard models 4910 and 4915 (Nos. 8, 9, 10 on photograph). New series utilizes a hollow phenolic tube around which the sensing coil is wound. As a high frequency carrier operated transducer, it works on a principle similar to the military mine detector and may be excited either by magnetic or nonmagnetic materials. Pickup is equipped with a cable and connector for attaching to a control unit containing the power supply and other electronic components. When used with Model 4901 control unit, it generates d. c. voltage when any metal object is dropped through the sensing coil. When used with Model 4901-R, hollow coil pickup will actuate electrical or electronic counters and automatic machinery. No mechanical contact is necessary. It will operate at rates from 0 to over 12,000 times per min. and may be used as part of a chute or tube carrying metal parts which can either slide or drop through the hollow coil. Models are available with inner coil diameters from ¼ to 3 in. Special sensing units can be provided to fit objects of odd size or shape. **Electro Products Laboratories,** 4500 North Ravenswood Ave., Chicago 40, Ill.

Circle No. **45** *on Reply Card*



No. 46—

Electronic Counter

Portable industrial counter measures frequency, speed, rpm, random events, weight, tempera-

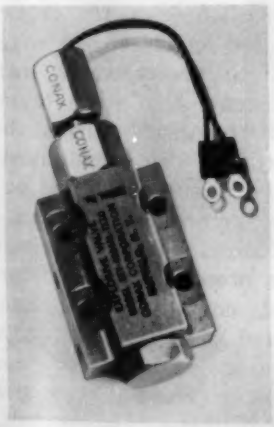
ture, pressure and acceleration. Instrument weighs 25 lb and is housed in aluminum cabinet. It provides direct numerical readings in cycles per second, rpm, or rps from 1 cycle per second to 120 kc. Period of count is either 1/10 or 1 second, and count display time can be varied. Instrument uses conventional power line frequency for counting time base, or is available with plug-in crystal time base for measurements of more precise accuracy. Unit includes three accessory power supplies of −150v dc, 300v dc and 6.3v ac filament supply. Connections are also supplied for photocells and external standard. **Hewlett-Packard Co.,** 275 Page Mill Rd., Palo Alto, Calif.

Circle No. **46** *on Reply Card*

No. 47—

Explosive Valve

Instantaneous operation of new valve is made possible by firing a small, completely contained explosive squib. Normally closed model is a dead-tight shutoff valve for long or short time storage of gas or liquid under high pressure. Flow passage is closed off by a solid, integral diaphragm between inlet and outlet ports inside the valve body. Upon firing, an unobstructed flow passage from inlet to outlet ports with an equivalent orifice of 9/32-inch diameter is opened in 0.002-sec. Only ½ amp. electrical current is required to fire the explosive squib. Smallest explosive valve weighs only 5 oz. and has a maximum operating pressure of 5000 psi and proof pressure of 10,000 psi. Valve is



Increasingly important to the guided missile program at Bell Aircraft, the development and broadened application of these and allied devices offers an opportunity and challenge to:

ELECTRONIC DEVELOPMENT ENGINEERS

including specialists in magnetic amplifiers, transistor circuits and airborne digital computer techniques to design and develop electronic components such as precise integrators, accelerometers, computers, feedback amplifiers, and instrument servos for use in inertial guidance.

SERVO SYSTEM ENGINEER

Analyze, design and develop complete systems for inertial guidance, with the help of a team of specialists.

SERVO VALVE DEVELOPMENT ENGINEERS

Design and develop high performance servo valves for autopilots in special aircraft, helicopters, and missiles.

To qualified personnel, these positions are well worth investigating. Get complete facts by writing (or sending resumé) to:

Manager, Engineering Personnel

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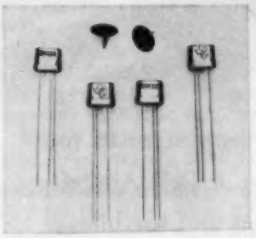
BELL Aircraft CORPORATION

P. O. BOX ONE • BUFFALO 5, N. Y.

sealed against back pressure up to 4500 psi on downstream side permitting proof testing of system before firing. Products of combustion are completely sealed in the explosive chamber eliminating any possible contamination of the system. Confinement reduces noise level of firing to zero. There is no sensitivity to physical shock. **Explosive Products Div., Conax Corp.**, 7811 Sheridan Dr., Buffalo 21, N. Y.

Circle No. **47** *on Reply Card*



No. 48—

Germanium Transistors

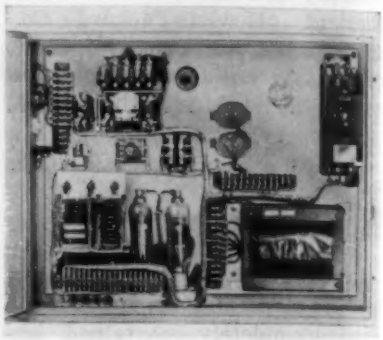
Designed for general purpose switching and computer applications, four new types of germanium n-p-n transistors feature a beta spread of two to one. Beta values for the individual types are 12 to 24, 24 to 48, 48 to 100, and 100 to 200. High speed switching is made possible by excellent rise time and cutoff time characteristics. Rise time in a typical circuit is 0.15 microseconds. Typical cutoff time is 3.5 microseconds. To assure maximum reliability, stability and long life, all units are cycled from −55 C and room humidity to 75 C and 95 per cent relative humidity for four complete cycles over a 24-hr period. Hermetic sealing is checked by vacuum testing and all units are thoroughly tested for switching characteristics. **Texas Instruments Inc.**, 6000 Lemmon Ave., Dallas 9, Tex.

Circle No. **48** *on Reply Card*

No. 49—

Electronic Control

Designed particularly for precise requirements of variable speed machine tool drives, new electronic control can be preset for specific spindle speeds, or supervised by mechanical or electrical means to provide continuously variable spindle speeds in applications where constant lineal speed is needed at tool tips or grinding face. Performance features make it well suited for improved performance of grinders, lathes, drill press, ball mills and other machines with up to 5 hp. drive motors. Control eliminates need for gear reduction equipment, pulleys, or less versatile, variable speed a. c. motors. It provides a flexible means of automating machine processes common to many industries. Control unit provides two full wave thyratron rectifiers; one to supply and control power for the drive motor field; and the other for similar armature service. Available field voltage and armature current is throttled by voltages taken from the motor field and armature. These voltages are fed to thyratron grids of the separate rectifier units. When motor drive is slow, increased field voltage is supplied through the thyratron's increased conductivity, to adjust speed to preset value. At the same time, the other thyratrons permit increased current in the armature. The simultaneous result is maintained speed at high torque, according to preset or automatic circuit settings. In instances where preset drive speeds are required, control can be manually adjusted. Adjustments can be calibrated for different turning speeds or according to grinding wheel diameter. In progressively changing conditions, such as the wearing of grinding wheels, reduced diameter of turned parts and feed rates to ball mills or other machines, drive motor speed control can be supervised by electrical or mechanical signals for auxiliary equipment. **Federal Pacific Electric Co.**, 50 Paris St., Newark 1, N. J.



Circle No. **49** *on Reply Card*

a *Brand* name is a *Grand* name

Anybody can make a cabinet or a relay rack. Only BUD has made products of this nature with special features found in no competing product. We're proud of our name and reputation, just as you are of yours. Our diversified line of sheet metal products and electronic components is skillfully engineered and economically produced; our know-how is based on over a quarter century of experience. Leading firms all over the country use us as a source of supply for our standard products or for production runs specially designed and fabricated.

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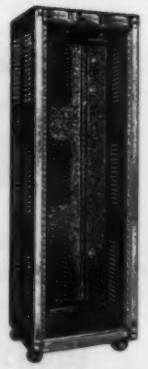

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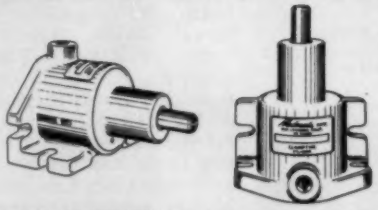

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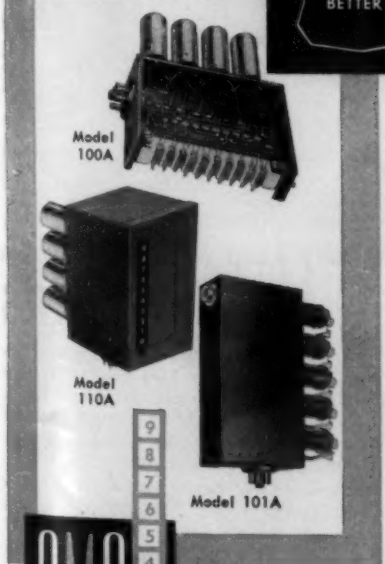

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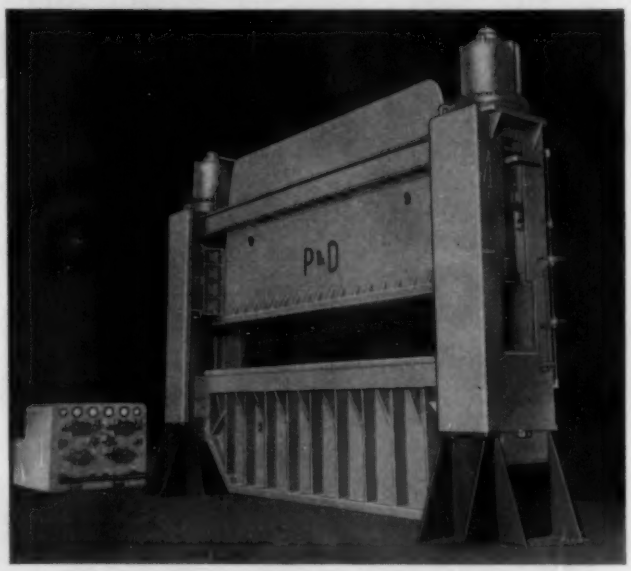

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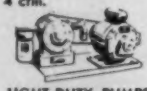

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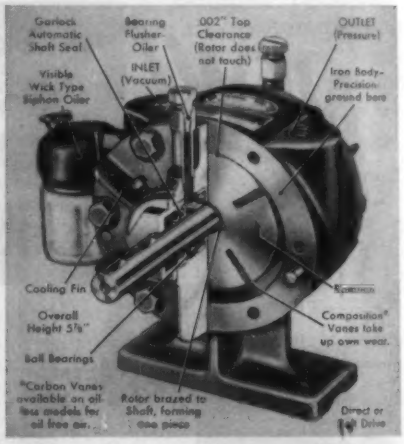
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Automatic Gaging

Pratt & Whitney Co. Inc., W. Hartford 1, Conn.—12-page bulletin—Designed for in-process gaging and final inspection operations, multidimension gaging machines are described in bulletin No. 592. Gaging machines are comprised of an indicator panel, gage head assembly, base unit and pedestal, each of which is described and illustrated. Two fully automatic, two semiautomatic and one manual gaging machine are illustrated and discussed. Fully automatic machines can be integrated easily into automated processes.

Circle No. 50 on Reply Card

No. 51—

Data Processing

Moore Business Forms Inc., Niagara Falls, N. Y.—120-page handbook—Newest developments for data processing are described and explained in handbook, MI-118, "Automated Data Processing." Simplified explanation of integrated and electronic data processing up through automated data processing is given. Numerous machines used for common language input and/or output are illustrated photographically and briefly discussed. Among these are the Flexowriter, typewriter tape punch, typewriter card punch, cardatype accounting machine, tape to card punch, teletypewriter set, electronic codewriter, automatic graphotype, and many others. Five-page glossary defines key words used in discussion of automated data processing.

Circle No. 51 on Reply Card

No. 52—

Solenoid Valves

Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.—8-page bulletin—New line of solenoid operated, pilot controlled valves is discussed in bulletin 5-C. Air, water and light oil valves are available in three and four-way models for pressures up to 150 psi and 500 psi. General valve characteristics, flow patterns, overall dimensions, photographs and ordering information are included.

Circle No. 52 on Reply Card

No. 53—

Pumps in Paper Making

Milton Roy Co., Station F, 1300 E. Mermaid Lane, Philadelphia 18, Pa.—16-page booklet—Use of controlled volume pumps to meter chemicals in stock preparation; bleaching; coating; slime, foam, and water control in the paper making industry is discussed in booklet No. 455. Actual case histories of installations in various paper mills illustrate use of the pumps. Six controlled volume pumps are pictured, with their specifications and capacities listed.

Circle No. 53 on Reply Card

No. 54—

Radial Ball Bearings

Miniature Precision Bearings Inc., Keene, N. H.—24-page catalog—More than 500 different radial ball bearings are described and tabulated by bore size—ranging from 0.0250 to 0.2500-inch—in comprehensive catalog. Torque, speeds and tolerances are discussed; radial and axial play and load life characteristics are explained and illustrated. Instructions for mounting, handling and lubricating miniature ball bearings are given.

Circle No. 54 on Reply Card

No. 55—

Speed Reducers

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—28-page catalog—New line of Gearmotors and Motogears which provides compactness and application flexibility is discussed in catalog 2447. The Gearmotor is a flanged motor combined with a housing with gearing, and is available in double and triple reduction types for operation up to 30 hp. Motogears are comprised of a motor, coupling, bracket and housing with gearing; units are also available in double and triple reduction types with operating capacities up to 60 hp. Catalog includes list of service classes, selection information, dimension data, and information on mounting assemblies.

Circle No. 55 on Reply Card

No. 56—

Lifting Magnets

Stearns Magnetic Inc., Milwaukee 46, Wis.—8-page bulletin—Reduction of materials handling time is one of the features of new circular lifting magnets described in bulletin 35-C. Design characteristics discussed are heavy bronze coil cover which provides a cushion against shocks and jars, ribbed case which provides greater radiation area for cooler operation, and mica plate insulation used inside the magnets. Two types of construction—bolted and welded—are illustrated and described. Photographs illustrate magnets being used in actual applications.

Circle No. 56 on Reply Card

No. 57—

Air Cylinders

Pathon Mfg. Co., Cincinnati 12, O.—16-page booklet—Line of double-acting air cylinders which are designed for operations requiring reciprocating action and the elimination of mechanical linkages is described and illustrated in booklet No. 23. Foot, rear flange, clevis, front flange, trunnion and center line mountings are illustrated. Specifications and schematic diagrams of seven models are given. Rod wipers, wrench flats, special piston rods and power factor are also covered.

Circle No. 57 on Reply Card

No. 58—

Material Handling Methods

Barrett-Cravens Co., 630 Dundee Rd., Northbrook, Ill.—16-page booklet—Practical, proved examples of use of company line of material handling equipment are given in illustrated booklet. Pictures demonstrate use of materials handling equipment in warehouses, machine shops, storehouses, loading docks, etc. Telescopic maintenance elevators are among equipment shown.

Circle No. 58 on Reply Card

No. 59—

Pneumatic Cylinders

Westinghouse Air Brake Co., Industrial Products Div., Wilmerding, Pa.—16-page booklet—Streamlined barrel construction is the feature of double-acting pneumatic cylinders described in booklet A3-41.01. Specifications, ordering information, mounting accessories, and cylinder levers are covered. Booklet A3-43.02 discusses diaphragm chambers and cylinders. Single acting, pneumatic power devices with internal return springs, convert the energy of compressed air into mechanical force. Devices are applicable in clamping, bending, holding, staking, piercing, pressing, feeding, broaching and positioning. Specifications and application photographs are included.

Circle No. 59 on Reply Card

No. 60—

Direct Reading Spectrometers

Baird Associates Inc., 33 University Rd., Cambridge 38, Mass.—8-page bulletin—Automatic servo monitor is the feature of direct reading spectrometers which are designed for metal producers and fabricators, railroads, and motors and aircraft industries. Experience indicates that new monitor has increased optical stability and reduced errors in analysis. Bulletin 44 includes information on the operation and construction of the direct readers, along with diagrams and photographs.

Circle No. 60 on Reply Card

No. 61—

Linear Potentiometers

George W. Borg Corp., Janesville, Wis.—16-page booklet—Important considerations in the application of linear potentiometers in such fields as computers and servomechanisms are discussed and illustrated in booklet BED-A42. Titled, "A Symposium of Technical Articles," the booklet also covers physical and electrical design characteristics of direct reading counting dials and potentiometers. Numerous graphs, charts and photographs are included to illustrate the discussion.

Circle No. 61 on Reply Card

No. 62—

Variable Speed Drive

Cleveland Worm & Gear Co., 3249 E. 80th St., Cleveland 4, O.—8-page bulletin—Compact drive which provides infinitely variable output speed over a range up to 9 to 1 from a constant speed power source, is discussed and illustrated in bulletin K-200. Speed regulation can be by automatic control, with pattern of regulation varied to meet application requirements. Photographs of several models, section diagram, rating tables and operating characteristics curves are included in the bulletin.

Circle No. 62 on Reply Card

No. 63—

Hydraulic Oil Filters

Hilliard Corp., Elmira, N. Y.—8-page bulletin—Available in automatic models for special applications, new line of hydraulic oil filters is described in catalog section 14-9. Filters are used by hydraulic power unit manu-

Circle No. 63 on Reply Card

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facturers, in plastic production plants, die cast plants, foundries and steel plants, production plants, by fork lift truck manufacturers, in aircraft plants and scrap yards. Photographs illustrate typical applications of filter system being used for continuous filtration of hydraulic oils on engine block multiple drilling and tapping machine, for continuous bypass filtration of hydraulic oil and for continuous filtration of way oil in broach. Installation diagrams are included in the bulletin.

Circle No. 63 on Reply Card

No. 64—

Magnetic Clutches and Brakes

Vickers Electric Div., Vickers Inc., 1815 *Locust St., St. Louis 3, Mo.—9-page bulletin*—Two new units called Magneclutch and Magnebrake which provide flexible torque control and power transmission, and preset or adjustable braking, respectively, are discussed and illustrated. Magnetic particle principle, upon which each of these units is based, eliminates gears, sprockets, linings, spring, air and fluid pressures, and other mechanical or centrifugal clutching devices. Also covered are an adjustable speed drive, and magnetic amplifiers which are used for the automatic control of power generating stations or with conveyor lines.

Circle No. 64 on Reply Card

No. 65—

Press Rebuilding

E. W. Bliss Co., 1375 *Raff Rd., Canton, O.—8-page bulletin*—Revitalizing older presses to increase their production and efficiency is discussed in bulletin 47. Eight steps in the rebuilding of old presses—such as the addition of a new clutch, drive or automatic controls—are illustrated and briefly described.

Circle No. 65 on Reply Card

No. 66—

Automatic Strainers

S. P. Kinney Engineers Inc., 201 *Second Ave., Carnegie, Pa.—26-page catalog* — Designed for the removal of suspended particles from all types of liquids for industrial use, new automatic strainers are illustrated and described in collection of data sheets. Automatic self-cleaning, manually operated self-cleaning, twin basket and twin basket self-cleaning strainers are covered. Photographs, descriptions, dimensions, capacities, and list of installations are included in catalog.

Circle No. 66 on Reply Card

No. 67—

Guide for Management

Teller Co., Group P., Butler, Pa.—20-page booklet—"A Guide for Selecting an Engineering Firm" is the title given to new booklet directed toward those people responsible for their company's entering new product fields, for plant automation, modernization or expansion. Differentiation is made between the engineering installation firm, the engineering project firm and the engineering design firm. Guides for selecting an outside engineering firm are included. Company facilities and engineering services including machine design and fabrication, equipment layout, procurement, installation, and general consulting services are discussed. Case histories of engineering design experiences are also given.

Circle No. 67 on Reply Card

No. 68—

Compact Motor

U. S. Electrical Motors Inc., Box 2058, Los Angeles 54, Calif.—12-page bulletin—Fully protected design is one of the features of Type H Uniclosed motors which are described in bulletin 1856. New component called the Ventrifoil, used at both air intakes of the motor, protects the interior. End brackets have air intakes arranged to prevent intrusion of water or dust, but allow air flow into the motor for two-way ventilation. Numerous illustrations are included in the bulletin.

Circle No. 68 on Reply Card

No. 69—

Gas Stream Controllers

Perkin-Elmer Corp., Norwalk, Conn.—8-page bulletin — Designed for dependable stream analysis, new infrared analyzers are the subject of illustrated bulletin. Illustration shows application of analyzers to feed stock evaluation, flue gas analysis, determination of intermediates, fractionation tower control and continuous analysis of finished product. Four series are described and illustrated, with their applications given. Specifications and price information are also included.

Circle No. 69 on Reply Card

No. 70—

Cylindrical Accumulator

Superior Hydraulics Div., 15201 *St. Clair Ave., Cleveland* 10, *O.—45-page handbook*—New safety disk used in the body of accumulators provides a safe medium for releasing precharge gas if thermal expansion develops to a degree approaching hazardous conditions. Illustrated handbook discusses construction and design features of accumulators with cutaway sketches showing component parts of different models. Double shell design provides a pressure balanced inner shell containing a piston as a separator between the precharge gas and the working medium. Outer shell acts as a gas container and a protective cover to insure that damage inflicted will not interfere with free movement of the piston.

Circle No. 70 on Reply Card

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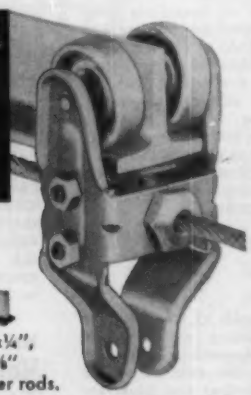

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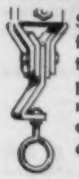

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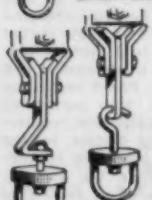

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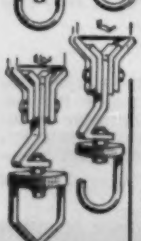

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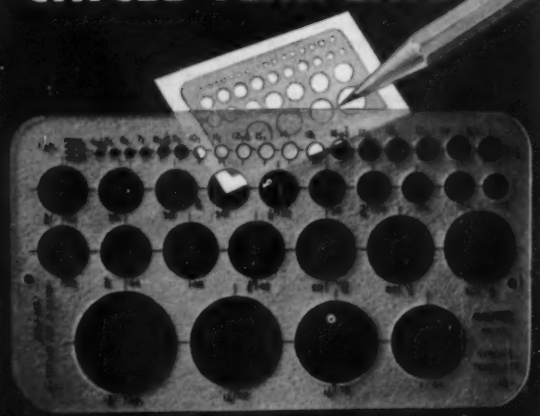

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No. 71—

Girder Cranes

Chicago Tramrail Corp., 1330 *S. Kostner Ave., Chicago* 23, *Ill.*—20-*page booklet*—Designed to solve materials handling problems, top running overhead cranes are the subject of booklet T202. Controls for girder cranes can be single speed automatic acceleration, two speed or variable speed. Both single girder models in capacities from 1 to 10 tons and double girder models in capacities from 2 to 12 tons are illustrated and described. Collectors, motor and reducer, cable rolls, bridge drive, brakes and pendant pushbutton control are also covered.

Circle No. 71 on Reply Card

No. 72—

Readout Systems

Fischer & Porter Co., 393 *Jacksonville Rd., Hatboro, Pa.*—12-*page bulletin*—Designed to speed up data handling for process industries, wind tunnels, engine test facilities and marine model basins, new multiple pressure readout systems are described in bulletin 58-15. Packaged systems use a single, high accuracy sensing device and pressure comparators to sample up to 200 pressures simultaneously with an accuracy of 1 part in 2000; manual logging is eliminated. Operation, applications and performance characteristics are illustrated with photos, dimension drawings and schematic diagrams.

Circle No. 72 on Reply Card

No. 73—

Flexible Metal Hose

Flexonics Corp., 1341 *S. Third Avenue, Maywood, Ill.*—12-*page bulletin*—Used on dust collecting systems, engine exhaust lines to eliminate vibration, conveyor lines, ion accelerators, platen presses, etc., new flexible metal hose is the subject of bulletin 152. Rex-Weld type, made of bronze, steel or stainless steel; Rex-Tube type, made of galvanized steel, brass, stainless steel, or bronze; and Rex-Flex models made of stainless steel are described. Five types of couplings are discussed and illustrated. Metal hose selection guide is also included.

Circle No. 73 on Reply Card

No. 74—

Processing Machines History

National Automatic Tool Co. Inc., Richmond, Ind.—32-*page catalog*—Application of automation principles in drilling, boring, facing and tapping operations by NATCO is photographically illustrated in new catalog. Pictures and brief explanations of automatic multiple spindle driller with 152 spindles in six heads manufactured in 1902 up through holeway processing machine with automatic pallet return conveyor of 1955 are included. Company engineering, manufacturing, and testing facilities are also discussed and illustrated.

Circle No. 74 on Reply Card

No. 75—

Rotary Air Pumps

Leiman Bros Inc., 102 *Christie St., Newark* 5, *N. J.*—12-*page bulletin*—Details of construction, dimensions, capacities and performance curves on line of rotary air and vacuum pumps are included in bulletin 755. Models discussed include four and two-wing types, double-cylinder type, and motor driven type. Also covered are integral pump and motor units, air motors and line of accessories.

Circle No. 75 on Reply Card

No. 76—

Reducing Piping Costs

M. W. Kellogg Co., Fabricated Products Div., 225 *Broadway, New York, N. Y.*—12-*page bulletin*—Method of evaluating stresses, reactions and deflections in complex piping networks is discussed in illustrated bulletin. Analytical method involves development and solution of simultaneous equations for determining forces and moments in the piping system. From these forces and moments, stresses and deflections are calculated. Since the analyses are not based on approximations, it is possible to specify more closely to the theoretically perfect piping design, thereby avoiding excessive and costly margins of safety. Bulletin describes a piping model test and its electronic computing facilities. Also included is the solution of a typical piping stress problem.

Circle No. 76 on Reply Card

No. 77—

Automatic Brazing

Selas Corp. of America, Philadelphia 34, *Pa.*—8-*page bulletin*—Soft-soldering and brazing are performed automatically by variety of specially designed machines illustrated in bulletin S-1050. Brief notes and sketches describe steps in solution of typical production brazing problem. Among brazing operations illustrated are brazing of copper tubes into cast iron headers, and brazing aluminum-bronze studs and copper wires to steel inserts in glass insulators.

Circle No. 77 on Reply Card

No. 78—

Strip-Chart Recorders

Bristol Co., Waterbury 20, *Conn.*, 12-*page bulletin*—Line of 6-inch strip chart recorders for pressure, liquid level, temperature, flow and mechanical motion is described in bulletin. Installation drawings illustrate methods of applying instruments to different variables; photographs show features of various models. Use of recorder as a receiver for remotely generated signals, either pneumatic or electrical, is also described.

Circle No. 78 on Reply Card

No. 79—

Alarm Systems

Scam Instrument Corp., 3855 *N. Kedzie Ave., Chicago* 18, *Ill.*—26-*page catalog*—Normal or abnormal operational conditions are

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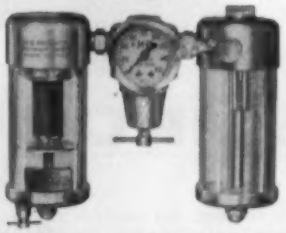

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both signaled and controlled by alarm systems discussed in illustrated catalog. Practical information on the selection, application and proper function of these systems throughout industry is included. Components of systems are illustrated, and operating characteristics and cutaway drawings are given.

Circle No. 79 on Reply Card

No. 80—

Automatic Screw Machine

Cleveland Automatic Machine Co., Cincinnati 12, O.—8-page bulletin—Spindle speed range, turret feeds, spindle head, cross slides, cut off attachment and the turret of new single spindle automatic screw machine are illustrated and discussed. Also shown are the universal camming feature, quick change collets, stock feed, controls and spindle bearing mounting. Infinitely variable spindle speeds and tool feeds are completely dial controlled. Specifications of the 1⅝-inch and 1⅝-inch models are included.

Circle No. 80 on Reply Card

No. 81—

Sensory Switches

Mercoid Corp., 4201 W. Belmont Ave., Chicago 41, Ill.—52-page catalog—Opening and closing of circuits by mercury switches in accordance with pressure, temperature, time, mechanical displacement or input electrical signals is possible with automatic controls illustrated and discussed in comprehensive catalog No. 856. Information on tilting and magnet operated types of mercury switches is also given. Specifications, photographs and operating characteristics of numerous models and types of controls are included.

Circle No. 81 on Reply Card

No. 82—

Processing Cylinder Blocks

W. F. & John Barnes Co., Dept. CB, 301 S. Water St., Rockford, Ill.—12-page bulletin—Equipment designed for automotive cylinder block processing ranges in size from 28-station unit performing 132 operations automatically to smaller four and five-station machines which perform only a few operations. Application photographs illustrate operations at various stations. Operations performed on each machine are listed, along with specifications and close-up view of part produced.

Circle No. 82 on Reply Card

No. 83—

High Speed Relays

Iron Fireman Mfg. Co., Electronics Div., 2838 S.E. Ninth Ave., Portland 2, Ore.—12-page bulletin—Designed for precision aircraft electronic equipment used in quality control, line of high speed and sensitive relays is the subject of bulletin R-55. Three styles of sensitive relays—dual four-pin loop, eight-pin miniature loop, and plug-in octal eight-pin—are illustrated. Operational charts which provide means for predicting the behavior of special values of coil resistance and other operating characteristics are given for both the sensitive and high speed types.

Circle No. 83 on Reply Card

No. 84—

Safe Trip Controls

Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.—12-page bulletin—Electric two-hand clutch controls for industrial machines are the subject of bulletin 65. Photographs illustrate trip controls being used with various types of clutches, air presses and pneumatic or hydraulic equipment. Equipment illustrated includes control boxes, hand switches; foot switch; limit switches, lock-out switch; and clutch actuating equipment including electric solenoids, air cylinders and air valves. Operating characteristics and specifications are included.

Circle No. 84 on Reply Card

No. 85—

Automating Machine Tools

Snyder Tool & Engineering Co., 3400 E. Lafayette, Detroit 7, Mich.—24-page catalog—Multistation transfer machines designed for various production operations are illustrated in new catalog. Types range from four-station machine designed for sawing, milling and hollow milling and centering both ends of railroad car axle shafts to 91-station machine for performing 182 operations on automatic transmission cases. Company's progress in automation over 30-year period is discussed. Two-page glossary of words and phrases dealing with automation is also included.

Circle No. 85 on Reply Card

No. 86—

Air Components

A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y.—36-page catalog—Line of air cylinders, valves, clamps and dial feed indexing tables is discussed in illustrated catalog. Valve in head, single and double ended cylinders; solenoid, pilot and hand air valves; spring return clamps and three models of dial feed tables are covered. Photographs, specifications, dimensional drawings and prices of air components are given.

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No. 87—

Gears and Pressure Switches

Southwestern Industries Inc., 5880 Centinela Ave., Los Angeles 45, Calif.—4-page pamphlet—Precision gears and gear boxes for instrument applications, servomechanisms, computers, small actuators and electronic components are described and illustrated in pamphlet. Vibration-resistant pressure switches for aircraft and missile systems are also covered.

Circle No. 87 on Reply Card

No. 88—

Automatic Strapping Machine

General Strapping Corp., 100 Park Ave., New York 17, N. Y.—6-page pamphlet—Steel strapping of all sizes and types of cases, cartons, bales and packages is possible with automatic machine discussed in pamphlet. Machine is readily adaptable to high production, conveyorized packaging lines, and will cycle at rate of 18 straps per minute. Application photographs are included in pamphlet.

Circle No. 88 on Reply Card

No. 89—

Industrial Relays

AEMCO Inc., Mankato, Minn.—4-page pamphlet—Photographs, specifications and application information on 24 types of relays are included in illustrated pamphlet. Variable mounting information is given; eight enclosure models for relays are also shown.

Circle No. 89 on Reply Card

No. 90—

Bagging Scales

Richardson Scale Co., Van Houten Ave., Clifton, N. J.—6-page pamphlet—Three basic styles of open type net weighers for free flowing materials such as grains, seeds, pellets, granular plastics, etc. are discussed in pamphlet 8246A. Floor portable type, overhead portable and overhead stationary models are photographically illustrated. Versatility of scale is shown in its application as duplex model, as a bulk unit and as a dock type scale for high speed operation at portside.

Circle No. 90 on Reply Card

No. 91—

Materials Handling Valves

Allen-Sherman-Hoff Co., 259 E. Lancaster Ave., Wynnewood, Pa.—4-page pamphlet—Design, operation and advantages of materials handling valves designed for pneumatic systems are discussed in illustrated pamphlet. Information on control techniques which are used with air-electric, remote or manual operation, and factors to be considered in designing a collecting hopper for proper flow of material to valve, are also included.

Circle No. 91 on Reply Card

No. 92—

Conveyor Belts

B. F. Goodrich Co., Industrial Products Div., Akron, O.—4-page pamphlet—Line of food handling conveyor belts which are highly resistant to vegetable, animal and mineral oils or greases, certain organic or inorganic acids, alkaline or neutral salts is discussed in pamphlet 2640. Belting is recommended for handling nuts, meats, greasy pans, cookies, bread and other products where belt temperatures range from 50 to 150F. Application photographs and specifications are included.

Circle No. 92 on Reply Card

No. 93—

Boring Machine

Ex-Cell-O Corp., 1200 Oakman Blvd., Detroit 32, Mich.—2-page pamphlet—New machine designed for precision machining of parts chucked on vertical spindles is the subject of illustrated pamphlet 31356. Two machine stations of vertical borer can be operated independently, with one station working one side of the part while the second station performs operations on the opposite side of the part. Specifications of machine are included.

Circle No. 93 on Reply Card

No. 94—

Turret Drills

Burg Tool Mfg. Co. Inc., 15001 S. Figueroa St., Gardena, Calif.—4-page pamphlet—Photographs illustrate five models of automatic and hand operated turret drills which are designed to drill, ream, counterbore, countersink, spotface, broach, and tap. Information and photographs of neoprene mounted, positive drive, full floating tool holders are also included.

Circle No. 94 on Reply Card

No. 95—

Control System

Daytronic Corp., 216 S. Main St., Dayton 2, O.—6-page pamphlet—Transducers which feature high accuracy, linearity and stability and which are used for measuring force, weight stress, etc. are illustrated in pamphlet. Also covered are transmitter for linear displacement; displacement indicator for pressure, flow and liquid level monitoring, control or measurement; and displacement controller for high speed weighing, gaging and sorting. Photographs and graphs are included.

Circle No. 95 on Reply Card

No. 96—

Vibrating Feeder

Richardson Scale Co., Van Houten Ave., Clifton, N. J.—4-page pamphlet—Photographs illustrate mechanical vibrating device feeding variety of materials ranging from soybeans to coke in technical pamphlet 55C. Operating principles and specifications of feeder which provides steady flow of loose bulk material

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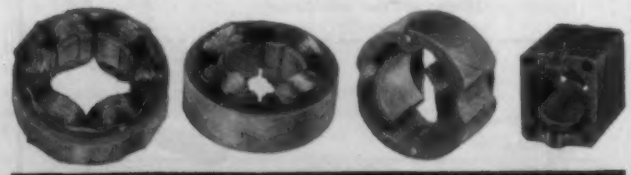

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57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96		

FOR EDITORAL CLIPSHEETS (Circle page number below)

Article starting on page—35 44 52 57 68 75
36 46 53 58 73

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IFC	13	22	32	89	100	106L	112BL	120TL	125BL	IBC
1	14	23	33	90-1	101	106TR	112BR	120BL	128BR	OBC
2	15	24	34	92	102	106BR	113BL	121	126TL	
5	17	25	79	93	103	108	113BR	122TR	126BL	
6	18	26	80	94	104	110BL	114L	122BR	127	
7	19	29	83	97	105TL	110BR	114TR	123L	130TL	
8-9	20	30	85	98	105BL	111BL	114BR	123R	130BL	
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43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96		

FOR EDITORAL CLIPSHEETS (Circle page number below)

Article starting on page—35	44	52	57	68	75
36	46	53	58	73	

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10	21	31	87	99	105R	111BR	118	124BL	131TR	

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abstracts

TRANSISTOR UTILITY IMPROVES

By DON E. BARNES
Bureau of Ships
Department of the Navy

THIS PAPER presents an estimate of transistor reliability. It is well known that the military is very concerned about the reliability of electronic systems. The extent of the concern and the complexity of the problem are discussed in Aeronautical Radio Inc. Monograph No. 1 on Electronic Reliability. This concern about reliability resulted in the institution of transistor reliability studies as early as 1951. While the theoretical and basic aspects of transistor reliability have predominated, Dukat of Raytheon in an AIEE paper and Ryder of Bell Telephone Laboratories at the University of Michigan have talked about the behavior of transistors in the field. In this paper we shall briefly review the history of transistor reliability and then approach the problem through selected answers to two questions: Has transistor reliability improved? Can transistorized equipment be designed now and be reliable?

In 1951 when the first transistors became available the outlook for improving reliability of electronic systems was optimistic. A circuit engineer could see a rugged device capable of withstanding shock, vibration and centrifugal requirements surpassing those previously permitted by the electron tube. Bell Telephone Laboratories reported that the first tests of this new device reflected slow, if any, aging of its electrical parameters. However, as the first production transistors became available it was discovered that too small a percentage of the produced devices were exempt from deterioration of essential electrical parameters. The problem was made even more distasteful by the fact that aging proceeded whether the device was in service or on the shelf.

Considerable effort over the past three years has been focused on this problem. The main mechanisms of misbehavior have been ferreted out. The one related to aging is an unstable surface condition. These ailments have been subjected to concentrated studies. "An estimate of the present position in fundamental understanding of semiconductor surface insofar as this is helping toward the solution of the surface problem—" has been presented by Garrett at the Electronic Components Conference in Los Angeles.

Results of curative measures as reflected in device aging studies are also of interest. *Fig.* 1 shows curves of collector current as a function of collector voltage with the emitter open circuited for two groups of five transistors each. The group on the left is as observed in 1954. These transistors were subjected to no abuse other than four months of shelf life. The group on the right is composed of transistors procured last spring. The dotted line represents the shape the curve could be expected to take if the collector voltage was increased. The group to the right is typical for transistors nowadays. Therefore, we can answer the first aspect of our problem. Transistor

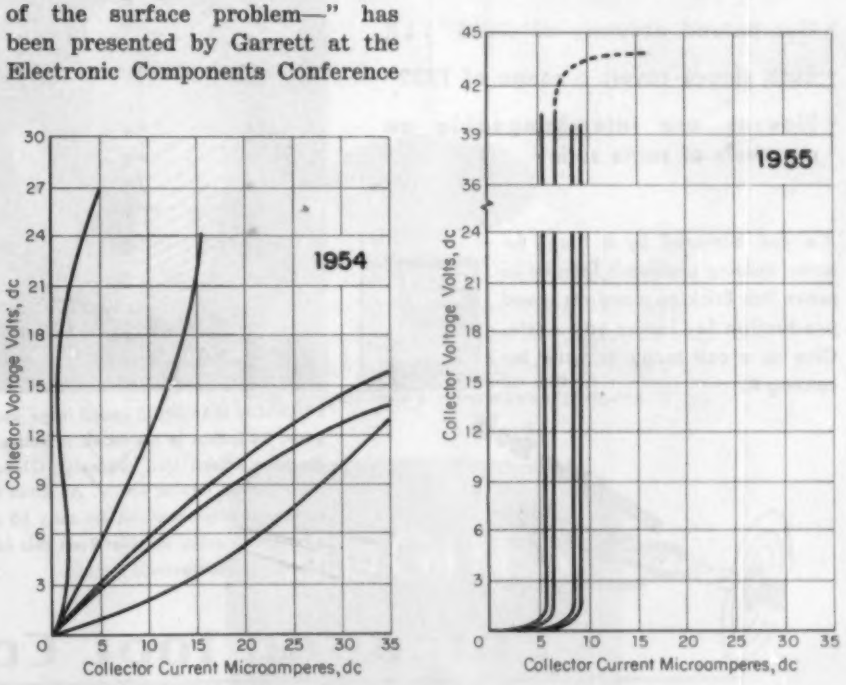
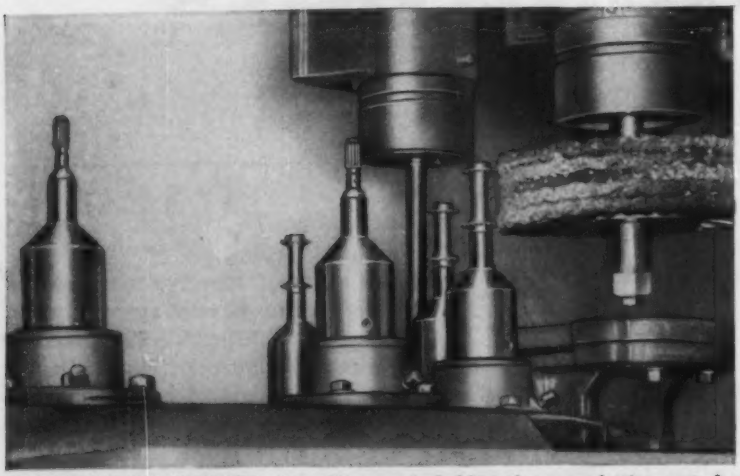


Fig. 1—Collector current as a function of collector voltage for two groups of five transistors each with emitters open-circuited. The group on the left is as observed in 1954 and was subjected to no abuse other than four months of shelf life. The group on the right was procured last spring and demonstrates improvement in characteristics made in a short period of time.

Self-release, greater grip, automatic alignment of ERICKSON MANDRELS speed small to large part loading



SMALL ERICKSON MANDRELS play a big part in holding down production costs for leading bicycle parts manufacturer. Here you can see how Erickson drawbar-operated, precision expanding mandrels speed wheel hub loading for buffing operation. Ease of operation and instantaneous release have greatly speeded this quantity production holding problem.

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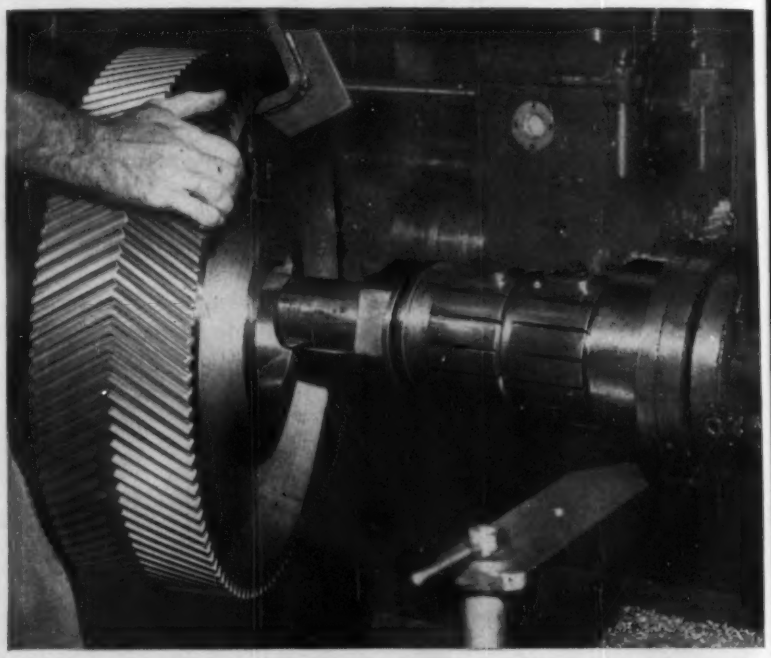
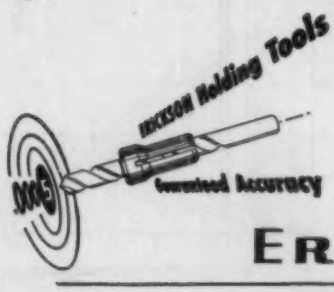


ERICKSON MANDRELS speed large part handling, too. See how easily this heavy shovel gear, 24 inches in diameter, is being loaded for gear cutting at the Alten Foundry and Machine Works, Inc., Lancaster, Ohio. Larger shovel gears up to 61 inches in diameter are handled just as easily. At Alten Foundry, using an Erickson mandrel, loading and automatic alignment require only 10 percent of the time required by plants using solid arbors and arbor presses. Even this large mandrel is self-releasing. Operator fatigue is practically eliminated.



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reliability has improved.

The next question regarding the reliability of systems is not as easy to answer. On the positive side are some enviable failure rates and the conclusions reached in regard to the first question. The transistors rugged features also contribute to circuit reliability. In addition duplicate circuits are feasible. Also to be considered is the fact that the transistor does not contribute to the local ambient temperature. Thus, associated components may be more reliable.

On the negative side are the vagueness of transistor aging behavior and the necessity of circuit stabilization. Well designed systems will have generous circuit margins Perhaps such systems will pick up more than their share of the reliability burden. If the system is so designed, reliability may greatly excel that which is now generally accepted. On the other hand, negligence in design, that is a lack of consideration for transistor weakness, will result in quite unpredictable reliability.

From a paper entitled, "A Review of Transistor Reliability" presented at the Annual Meeting of the American Rocket Society in Chicago, Nov. 1955.

WAREHOUSING IN STEEL

By C. L. HARDY
President
Joseph T. Ryerson & Son Inc.

LET US LOOK at the future. The ingot capacity of the country on Jan. 1, 1956 was set at 128-million tons, up 40 per cent in a decade; in 20 years up 64 per cent. If growth is continued at the same rate, 20 years from now our ingot capacity could reach 200-million tons, which in turn will mean a production of something over 145-million tons of finished steel. The steel warehouse distributors, if their percentage of growth continues as in the past, should account for the distribution of 22 per cent of this output or approximately 32-million tons. This is nearly double the tonnage handled in the year of 1955.

Within 10 years, many warehouses will be equipped with a

transistor and
digital computer techniques

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Engineers & Physicists

Digital computers similar to successful Hughes airborne fire control computers are being applied by the Ground Systems Department to the information processing and computing functions of large ground radar weapons control systems.

The application of digital and transistor techniques to the problems of large ground radar networks has created new positions at all levels in the Ground Systems Department. Engineers and physicists with experience in the fields listed, or with exceptional ability, are invited to consider joining us.

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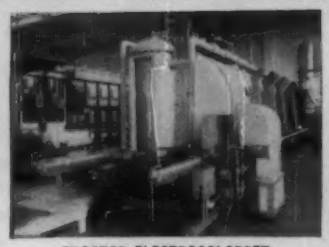

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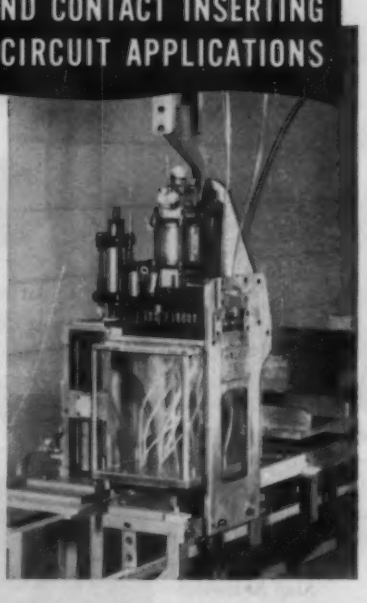

Request Bulletin 551. Better yet, give us the facts about your operation. We'll show you how your costs can be lowered and your production increased.

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series of belt conveyors which will bring material from the processing point to the shipping floor automatically. Such conveyors might also take the form of automatically indexed, electrically powered floor type conveyors to transport material from slitting lines to shipping floors or from stocking areas to shipping floors. Another method which may in the future do a similar transporting job is the combination of radio-wire trackless trucks which will follow a guided path established by wire strung high in the trusses of a building.

These methods of transporting steel will be augmented by additional fork truck units of conventional design, and further use of straddle carriers which first came into popularity in the lumber business.

At some future date, we may see combinations of bridge-type cranes with fixed appendages hanging from the bridge, dropping to the floor with forks which utilize high storage racks, thus permitting more tons of steel to be stored in the same square foot area. Still another method of improving storage may be a large ferris wheel with built-in racks, and a push-button selector to rotate the desired size and shape of steel to the proper position for order filling or production.

In shipping, there has already been developed a removable truck body which can be preloaded on the floor from the warehouse area, and then the entire body of the truck picked up and loaded on a trailer or straight truck chassis. Automatic banding lines for coils and wire are already in use, and with innovation can be redesigned to band various other types of commodities.

You are all familiar with the new electronic devices which speed order-writing, billing, accounting, and inventory control. Great strides in this direction will add to the efficiency, and lower costs at the warehouse level. New developments in the communications field will accelerate the speed of warehouse service and put our stocks on a more nearly equal basis with your own storerooms.

Automation, both for processing

and handling, is our only defense against the trend toward higher and higher wage rates. The steady growth of our industry, the increasing share of our participation in the distribution of steel from the producer to the consumer, is evidence of our ability to give economical service. It is only by economies in operation that we can maintain and better our position and that is the challenge that the warehouse industry readily accepts.

From a talk entitled, "New Horizons for the Steel Distributor" presented at the Annual Steel Meeting of the Ft. Wayne Association of Purchasing Agents, Feb. 1956.

WHAT'S IN THE RECORD

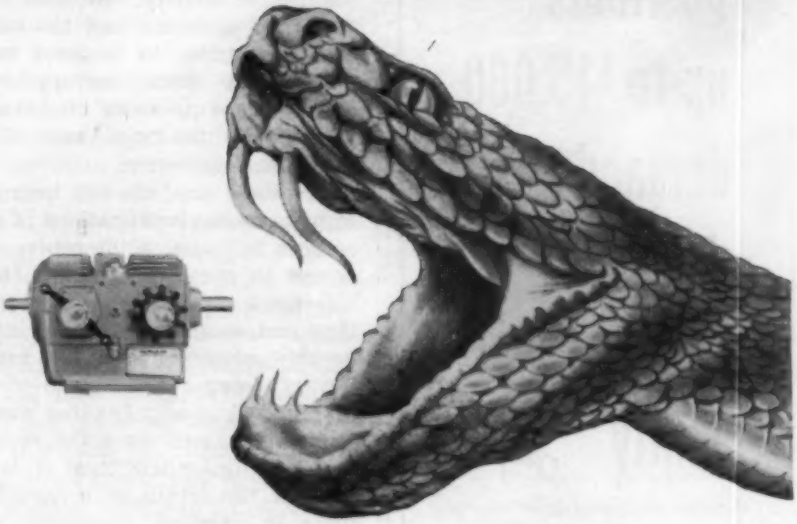
By RAY P. DINSMORE
Vice President
Goodyear Tire & Rubber Co.

ACCUMULATION of recorded knowledge has been going on at an accelerated pace. In the past few decades it has grown in geometric proportion. The result is that each of us must be highly selective in what and how much he attempts to assimilate, with a view to preparing to function best in his own special occupation and in his chosen social acts. We have as a consequence come to be headline readers, followers of radio commentators and newspaper columnists, and supporters of various publications which supply information in condensed or tabloid form.

Of course by so doing we transfer to others the selection of facts or items of information and the emphasis with which they are repeated or discussed. To be sure we retain for ourselves some degree of censorship by testing our sources of information against those portions of knowledge in which we are expert or with which we are more than familiar. By this means we can separate the honest men from the knaves, but we lack a proper basis for discounting personal enthusiasms or antagonisms and differentiating between comments made from real experience as compared to those which are superficial.

In the realm of science and in-

We wore out 110,000 Rattlesnakes



Have you ever been awed by the rapidity with which a rattler strikes and recoils? You should be! Old "diamond-back" can lash out and reverse himself in about 1/10th of a second. There's one catch—he wears out after a second or so of continuous activity.

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can be fatiguing for machinery as well as rattlesnakes, but . . . for the record, we reversed a GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION (under load) over a million times—continuously at a rate of 22 times per minute—without the slightest sign of wear to the Gerotor Transmission.

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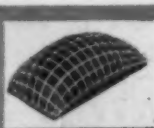
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COMPUTERS—

supervise Analog and Digital Computer design and development.

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dustry it has become more and more difficult to keep abreast of modern developments even in a limited field. Technical publications are so numerous that it would be impossible for the average individual to read all the articles which are published in connection with his field of activity. He must then resort to abstracts and the selection of articles to be read thoroughly only when they appear to be of major interest or because they are written by authors of unquestioned authority.

Certainly any marked improvement in cross-classifications of references in technical literature and means to speed locating of these references would be a saving in time and manpower and not infrequently would obviate the necessity of doing certain parts of research work at all. In other words, it is often easier to make certain investigations anew than it is to discover the details with regard to them in existing literature, and without better methods this situation will get worse.

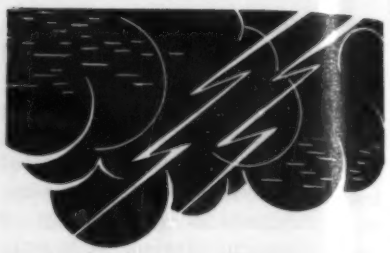
Obviously, with modern industrial society so highly dependent upon the advances made in the engineering applications of science, not only for its improvement in the living standard of its civilian population but also increasingly for its military defenses, this situation must be corrected.

From a talk entitled, "Whether There Be Knowledge" presented at the Conference on Practical Utilization of Recorded Knowledge held at Western Reserve University, Cleveland, Jan. 1956.

STANDARDIZATION IN ELECTRONICS

By C. J. LAWSON
Director of Standards
International Business Machines Corp.

RAPID development of electronic data processing machines has posed problems for us in standardization as well as in all other operations in our business. IBM, as compared with automobile, radio, television, or other such manufacturers, produces a very low volume of specific machines of any one type and the area which holds the only real possibility of volume manufacturing or assembly is that comprising parts,



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Clearly and thoroughly shows you how to select and use the new electronic clerical systems in your company. Written in the language of management, and requires no previous knowledge of electronics. Shows how the systems operate (with case illustrations); how to determine the special needs of your firm; and gives reliable information of what's available commercially to meet those needs.
1956 332 pages $7.00

OFFICE WORK AND AUTOMATION

By HOWARD S. LEVIN,
Consultant for Ebasco Services, Inc.

A book for the business decision-maker, this work serves as a valuable guide in today's rapidly changing management patterns. A sound basis for understanding the advances being made in the handling of business information, it offers new perspective for management planning and provides valuable warnings as to pitfalls in office automation. Includes especially useful illustrations, charts, and tables.
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MACHINE TRANSLATION OF LANGUAGES

Edited by WILLIAM N. LOCKE and A. DONALD BOOTH, with 17 International Authorities.

First to survey the field, this book offers answers to many provocative questions and provides enlightening comment and information even on questions which cannot yet be answered. Covers such subjects as: the design of an automatic dictionary; what a "word" is; an operational analysis of Russian; speech input; storage devices, idioms and syntax; model English; and recent experiments. *(A Technology Press book, M.I.T.)*
1955 243 pages $6.00

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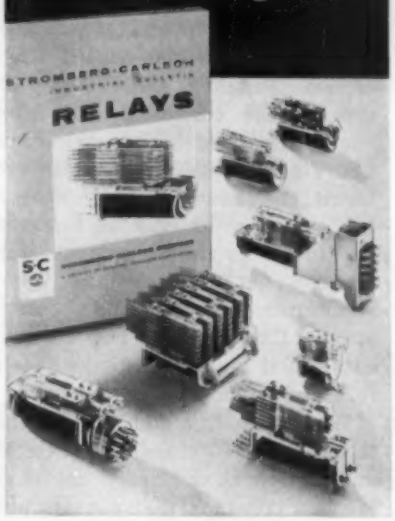
components, and functional assemblies or subassemblies.

Consider the pluggable circuit units, for example, in the large 700 series of data processing machines. Despite the rapid development of these machines, considerable effort was extended by our engineering organization to standardize wherever possible, and yet by analysis we find that in one of our early machines which comprised 383 eight-tube pluggable units for each of our main arithmetic and logical frames, 189 of these were of different types. In another machine comprising 790 pluggable units, 394 were of different types and all 394 had not been previously released in prior machines. In still another, we had 469 pluggable units of 242 different types of which 160 had not been previously released. To this total we added for the 705 and other recently developed special purpose machines, 375 new pluggable units which had not previously been released. We are, therefore, faced with the total of 1118 different pluggable units being processed through manufacturing as a result of the rapid development of this series of computers. It has been conservatively estimated that if there had been no standardization effort during these developments, the number of different types would have been increased by a factor of 2½ to 3.

There should be no difficulty in realizing the control and production problems presented by such a diversity of unit types or in realizing the impediment which this presents to good automation in our factories when it is recognized that each of these units must be carefully tested in each step of assembly, further tested as it is mounted to panels, tested again as it is assembled on gates, and tested further as it is connected to each other operating function in the machine, and then finally tested as a complete unit. So it can be seen that our automation problems are not merely in manufacturing and assembly but that a larger volume of fewer types would permit the introduction of automatic test equipment of a high order in each step of the manufacturing and assembly process.

It becomes apparent, therefore,

TWIN CONTACT
Relays



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For many years, Stromberg-Carlson production of twin-contact Telephone type relays has been completely absorbed by the independent telephone industry.

Last year, we became a division of General Dynamics Corporation. A five-million-dollar expansion program is under way and one result is already increased relay manufacturing facilities, enabling us to broaden our distribution.

These relays—proven by years of reliable service in the telephone field—are designed to operate under extreme ranges of temperature and humidity. They are made in many types of which these are typical.

Type A is a general-purpose relay especially adapted to the control of switching operations.

Type B is a gang-type relay which can be equipped with three times the number of spring combinations as the "A" type.

Type C. Two relays on the same frame; mounts in same space as the "A" type. It is particularly effective where small space is a factor.

Type D. Miniature general-purpose relay of approximately ⅓ the size of "A".

The catalog in the photograph above gives fuller specifications. We'll gladly send one on request.

S-C
STROMBERG-CARLSON

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that standardization becomes essential, but what type of standardization? We do not wish to inhibit engineering initiative in the development of new techniques and circuitry. To promote standardization through the use of single circuit pluggable units vastly increases the complexity of interconnections and back panel wiring and also increases impedance problems, the answer to which necessitates the use of cathode followers and increases the component count and cost. On the other hand, circuit standardization permits greater standardization of other components, such as tubes, diodes, resistors and capacitors.

What does this add up to? One thing so far — standardization for automation is decidedly not easy. We can conclude that considerable standardization has been accomplished, but a great deal more is needed for real automation in the areas already mentioned and in specific areas such as automatic wiring, automatic core assembly, automatic testing, automatic design, and so forth.

In the words of Mr. A. E. Vinson, of the General Electric Co., "Management must realize that an automation program embraces all the functions of the business and not just the techniques of manufacturing. Management must recognize that an automation program is a step by step analysis of a company's products from the financial, marketing and engineering viewpoints which results in simplification and standardization, the two keys to the successful application of automation in the factory. It is up to management — management with vision, enthusiasm, imagination and courage — to determine the degree of automation that their business requires and then develop an overall progressive program and see that it is properly carried out. Those who fail to do so will slowly lose ground just as surely as those who attempt the program on too sweeping a front will lose their shirts. The game is going to be rewarding for the successful but very punishing on the reckless."

We believe that the solution is threefold: First, standardization and automation feasibility must be designed into the product from the outset; second, automation must be designed parallel to the product design and must be programmed for maximum flexibility, which is the key to good automation; and third, both product and production design must point not only at the immediate project, but must encompass the farthest horizons.

Plans for the Future

I cannot be completely free in discussing our plans for the future, but in the 608 Transistor Core Calculator circuits are being designed by a group of transistor circuit specialists who are looking constantly ahead to future machines. Circuits are being packaged on standard printed wiring boards by a group of specialists who are working constantly with manufacturing engineers, all of whom have automation and future machines in mind. Machine packaging is being developed along standard modular lines by a group

engineers BS EE ME

to help develop All-Out Automated Factory producing complex Electronic Equipment

This General Electric Department at Utica, N. Y. is already 40% automated—now a newly formed Advanced Development group will undertake the challenging assignment of putting production on a fully automated basis.

This is a job that will never be 100% completed. Our experience already shows that the more you automate, the more orders you get, the more new equipment you design, the more new automated systems you need, and so on, *ad infinitum*.

Openings Line Up This Way:

Electronics—for engineers interested in working with logical circuits and servomechanisms to develop remote control manufacturing systems involving unique electronic problems.

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Materials—for engineers to investigate and develop new techniques and materials for mechanized manufacturing. Must be familiar with metals, plastics and fabrication techniques.

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See Page 115

of specialists working constantly with manufacturing engineers, all of whom likewise have automation and future machines in mind.

Both development and manufacturing engineers are concentrating on specific phases of automation development. In addition, a specific group in manufacturing research is devoting its full effort to factory automation. I am not suggesting by any means that IBM is in any position to boast about its automation accomplishment. We, too, are in an evolution stage where much planning and considerable design is in process but not yet too much in operation except as single units rather than a series of units in a continuous automatic line.

From the foregoing you will readily see that we have made only a start in automatic factory production of the type we are talking about, but I can assure you that that start is a forerunner of many things to come.

In conclusion, let me stress that we are convinced that standardization must not be rigid in IBM. It must be ready to drop one standard for a better standard as rapidly as one is developed, but it must not permit non-standard variation without reasonable benefit to the company, when considered from all angles.

IBM has been built upon the premise of providing maximum benefit to the customers, sometimes through special purpose machines to meet specific customer problems. There is no intent to standardize the end product. Standardization is pointed toward parts, components, and modular assemblies which will enable us to achieve comparatively large volume of modules and still build special machines more economically for the customer.

Such standardization is a must in order to provide possibilities for automation.

Standardization must begin on the drawing board and be carried forward to the finished product.

Automation must be developed jointly by engineering and manufacturing and must provide flexibility for changes and programming for short production runs.

Both standardization and automation must be broad company programs directed and supported by all factors of company management.

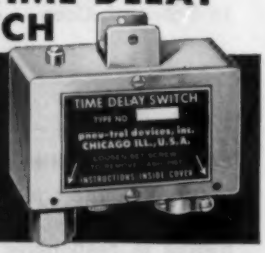
Standardization and automation are the responsibilities of all engineers, not just standards engineers or automation engineers.

From a paper entitled, "Without Standards, No Automation" presented at the National Convention of the Standards Engineers Society in Hartford, Conn., Sept. 1955.

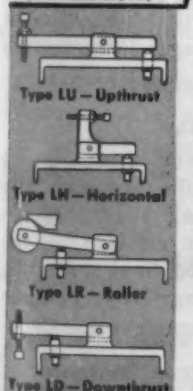
". . . knowledge is the child of practice and theory. It follows, therefore, that master builders who have aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their pains, while those who relied only on theories and scholarship were obviously hunting the shadow and not the substance. . ." — *Vitruvius, De Architectura (ca. 15 B.C.)*

Pneu-Trol TIME DELAY CONTROL SWITCH

...Gives Cylinder Applications Greater Efficiency Accuracy ...Wider Use!

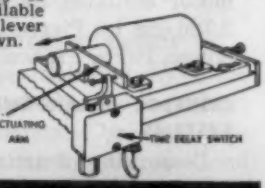


For any type actuation Left or Right Hand. (Left Hand shown)



- Holds Cylinder dwell accurately to fraction of second. • Automatically re-sets.
- Simple, Compact, Rugged.

You can hold any motion or operation controlled or actuated by air or hydraulic cylinders at a positive stop on either end of the stroke for ¼ to 60 seconds in 20 to 1 ratios with Pneu-Trol Time Delay Control Switches. Simple in design with positive hydraulic timing action . . . compact and easily mounted on the machine or fixture. Pneu-Trol Switches are providing millions of trouble-free actuations in solenoid-operated cylinder applications of every type. Positive, controlled time dwell permits wider use of air or hydraulic power in automatic operations, increases accuracy of work by insuring split-second accuracy of the dwell. Available with 5 actuating lever linkages as shown.



Switch mounted to provide dwell at end of power stroke of single action, spring return cylinder.

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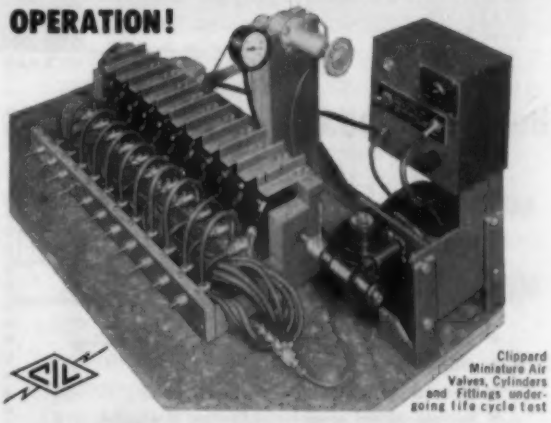

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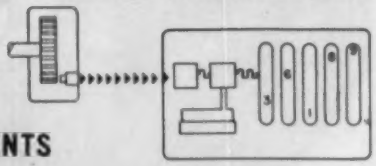

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67

AUTOMATION

patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

Computers

ELECTRICAL COMPUTERS

To solve the equation $A \times B = C \times D$ of which A, B and D have predetermined amplitudes, ac voltages are manipulated by transformer circuits. Patent 2,733,004 by John E. Richardson.

OPTICAL ANALOG COMPUTER USING PROJECTED LIGHT PATTERNS

Effect of a number of factors having two parameters are summed optically by use of a common light source and means for independently adjusting the intensity of light patterns representing the factors and projecting them on a common area. Patent 2,733,631 by Dan McLachlan Jr., assigned to Research Corp.

• • •

Controls

WINDING MACHINE STOPPING SYSTEM

In unwinding a strand from a wound package, a photocell electrically connected with a stopping means is responsive to change in intensity of reflected light when the core surface is exposed, and actuates the stopping means at that time. Patent 2,725,710 by Robert D. Heffelfinger, assigned to American Viscose Corp.

WEB POSITION CONTROL MECHANISM

Edge alignment of a moving web is maintained by a combined pneumatic-hydraulic system. The edge of the web passes over an air suction nozzle varying pressure in an air line in relation to web position. Web position is adjusted by a hydraulic motor actuated by air pressure variations. Patent 2,726,858 by Pierre Cherigie, assigned to La Cellophane, Paris, France.

CONTROL ARRANGEMENT FOR ARTICLE DISPENSING SYSTEMS

Dispensing of articles from a plurality of storage and releasing devices is controlled by a selecting mechanism and article registering means so that articles selected in a batch are released simul-

taneously. Patent 2,733,833 by Thomas S. Skillman, assigned to Punch Engineering Pty. Ltd., Sydney, Australia.

• • •

Handling

CONTROLLED MATERIAL-HANDLING AND TRANSFERRING APPARATUS

Work is transferred from one or more stations in a closed path to other stations, independently of work at any other station, by co-operation of electrically controlled independent hoisting mechanisms at each station and an endless belt conveyor above the stations. Patent 2,732,962 by Edward P. Bullard III, assigned to the Bullard Co.

CONVEYOR TRANSFER MECHANISM

Articles are automatically transferred between separate conveyors by a carrier movable on a frame between the conveyors. Patent 2,731,127 by Homer S. Harrison, assigned to Allied Steel & Conveyors Inc.

• • •

Machine Tools

MACHINE TOOL

Cutting means with adjustable depth of cut is moved on a frame over a work-supporting surface and provision is made to produce nonparallel as well as parallel cuts. Patent 2,730,020 by Latham Pollock and Joe S. Appleton, assigned to North American Aviation Inc.

• • •

Measuring

THERMAL FLOWMETER

Flow of a medium through a conduit is measured by means of an electrical bridge balancing temperature values before and after heating of the flowing medium by a heating means. Patent 2,729,976 by John H. Laub.

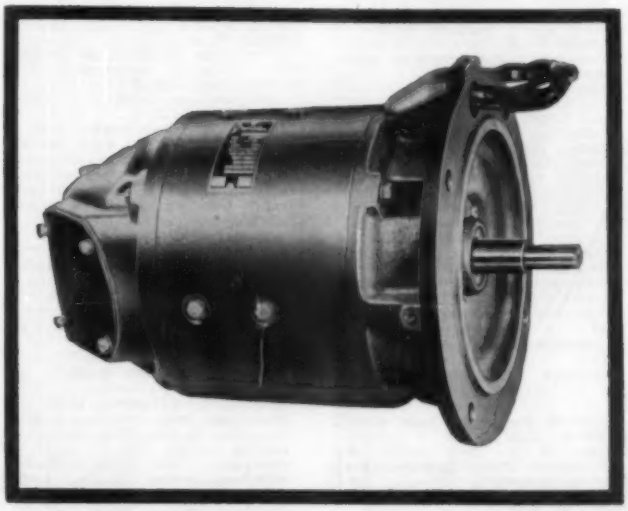
INSPECTION DEVICE

Presence or absence of container contents at a given level is determined by measuring the ac impedance of an x-ray sensitive semi-conductor disposed near the side of the container opposite a source of cyclically pulsating x-rays. Patent 2,732,503 by John E. Jacobs, assigned to General Electric Co.

MAGNETIC DRAG SPEED MEASUREMENT DEVICE

Speed of shaft rotation is indicated by force exerted on a magnetic drag member by a magnet rotating on the shaft. A pneumatic pressure representing the speed being measured is obtained and automatic temperature compensation is included. Patent 2,731,025 by Herbert A. Neuman and Stuart W. Sweet, assigned to the Foxboro Co.

Direct Current TORQUE MOTOR PRECISELY POSITIONS HEAVY DIES



This Peerless direct current torque motor was designed specifically for one of our customers. It operates through a gear unit to smoothly position heavy dies on die-making machinery. An adjustable brush mechanism and rugged construction permit the design to be extremely sensitive and accurate — a necessity for precision die alignment. The motor pictured is one of many DC torque motor designs available at Peerless in the 1/2-3 HP range.

Peerless-customer teamwork made this motor possible. We can apply our motor knowledge to your application in the same way. Let us check your "specs" and give our recommendations. We'll help you select the one motor that powers your product best.

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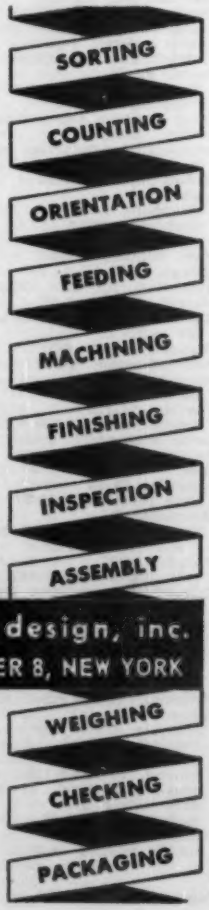

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